Hollies, R.T.

Preliminary investigation of the weathering of Alberta coals. 1921.

PRELIMINARY INVESTIGATIONS

ON

WEATHERING

OF

ALBERTA COALS.

By

R. T. Hollies, B. Sc.

CONTENTS.

Page

On Page 10 is given the preliminary programme for coal research which the Provincial Government has authorized to be conducted by the Industrial Research Department at the University of Alberta. The work performed by the writer and included in this report comes under the heading of item 9 of that programme.

INTRODUCTION.

General Statement and Object of Investigation.

The Coal Industry of Alberta is having an uphill fight in widening the markets in the provinces of Alberta, Saskatchewan, Manitoba and Western Ontario. The chief opposition is due to the prejudice of the public of the western provinces as regards the suitability of the coals for various industrial and domestic uses, and more especially in regard to the weathering in storage.

It is estimated that the province of Alberta contains **fifteen** per cent.[1] of the coal reserves of the world, and eighty per cent. of the coal reserves in Canada. The quality of the coal varies from lignite to anthracite, the latter occurring in the mountains. It is thus clear that an unlimited coal supply for all varieties of purposes can be mined within the province, once the public realizes that the local coal is as good as any of the imported varieties and can be bought at a cheaper rate.

The Provincial Government has authorized a

([1]) Allan, J.A.,"The Mineral Resources of Alberta," First Annual Report, Mines Branch, Alta., 1920, p.46.

Committee of Industrial Research to further the mineral development of Alberta by tests and educational propaganda based on the results of the tests. It is the purpose, then, of these investigations to determine the properties of Alberta coals and especially to discover suitable means of storage which will enable the coal operators of the province to ship coal to outside points during the summer when both the coal mines and railways have their slack season. This will have the desired effect of equalizing the mining industry throughout the year, to the undoubted benefit of both operator and mine-worker, besides providing increased traffic for the railways during the present slack season.

Some mines use grizzly, or bar screens, and others perforated plate screens, and no data are available as to the equivalency of the two. As a consequence confusion exists between producer and consumer in regard to what is meant by the present list of sizes supplied. Work is being done to get a standard equivalency for these different styles of screens, and some suggestions in this regard are embodied in this report.

Technical Staff.

The coal screening, storage and equivalency tests have been carried out by Mr. R. T. Hollies, B.Sc., assisted by Mr. T. Holmes, in the Mining Engineering Building.

The chemical analyses, including the heat value of the coals, were done by Mr. R. T. Hollies, B.Sc., under the supervision of Mr. J. A. Kelso, M.Sc., Director of the Provincial Industrial Laboratories.

The boiler trials were conducted by Professor C. A. Robb, M.Sc., Associate Professor of Mechanical Engineering, assisted by Mr. H. A. McMillan, Chief Engineer, University Power Plant and by Mr. R. T. Hollies, B.Sc.,

Professor N. C. Pitcher, M.Sc., Professor of Mining Engineering, University of Alberta, has supervision of all investigations.

Acknowledgements.

The coal research was not commenced until after the beginning of the present (1920-21) session of the University. Many unforseen difficulties were encountered in organizing and carrying out the investigations; these were overcome by the writer chiefly through the co-operation and

kindly advice freely given by the staff of the Department of Mining Engineering and by members of other departments.

The writer wishes to acknowledge the capable assistance rendered by Mr. T. Holmes in carrying out the screening, sampling and sorting tests. Professor N. C. Pitcher, M.Sc., Professor of Mining Engineering, has kindly offered many helpful suggestions and by his keen interest in the work has very materially assisted the writer in getting results. Professor A. E. Cameron, M.Sc., Associate Professor of Mining Engineering, has always been ready to render valuable assistance and advice during the entire investigation. Acknowledgement is also due Mr. J. A. Kelso, M.Sc., Provincial Analyst, for his valuable advice and kindly criticism in the chemical work.

Laboratories.

(a) The screening is done on a shaker screen (see figure 1, next page) purchased from Messrs. Donkin and Stevens, of Edmonton, and placed in the University Mining laboratory. Difficulty in getting the machinery ready in the fall of 1920 prevented

as early a start as was planned. It was not until November 8th that the first part of car load of coal was received. When this lot of coal was disposed of, difficulty was again encountered in getting the next lot of coal, due to a local coal miners' strike tying up the mines from which the coal had been promised. This second lot was not received until December 15th.

Fig. 1.-- Screening Mine Run.
Left to right: Scales, Feeding Hopper, Nut Slack discharging into box, Egg discharging into box, and Lump discharging into wheelbarrow.

(b) The chemical analyses are all being made in the Provincial Industrial Laboratories as noted above.

(c) The boiler trials are being conducted at

at the University Power Plant, No. 2, both in hand-fed and stoker-fed Babcock and Wilcox boilers, using chain grate stokers of the close link type.

(d) Storage.

1. Open storage, where coal is dumped on the ground, capacity = 35 lots of 1 ton each.

2. Shed storage was provided for by special shed built near the University Power Plant No.2, capacity = 18 lots of 1 ton each.

Fig. 2.-- Open Storage Piles in rear of Storage Shed. Note tar-paper roof to latter.

3. Pits for storage near the sheds were dug and covered in, capacity = 15 lots of 1 ton each.

Description of Storage Facilities.

Each size of each sample of coal is stored in half ton and one ton lots in the open, in pits and in shed respectively. The following is a rough description of the storage facilities:

1. Open Storage.-- (See figure 2, previous page.)

Fig. 3.-- East Side of Storage Shed with Lids of Two Storage Pits in Foreground.

Adjacent to and west of the storage shed described below an area 40 feet square has been cleared of poplar opplar and underbrush on the ground for half ton and one ton lots of the different sizes of the different samples, no precautions being taken to insure drainage, to protect the stored coal from the weather or to prevent the coal being mixed with dirt when

removed for sampling and testing after storage.

2. Pit Storage.-- (See figure 4.) Adjacent to and east of the storage shed are the storage pits. Each is 20' long, 5'6" wide at the top and 4' wide at the bottom and 3' deep. They are lined with poplar poles and divided into compartments 5'6" x 6' at the top and 4' x 6' at the bottom and 3' deep. These pits are of ample size to store 1 ton samples. The bottom is of clay, levelled and tamped hard, and affords a clean surface on which to dump the coal. The pits are well covered by tightly fitting 1" shiplap lids

Fig. 4.-- Inside of Storage Pit. Coal can be seen in near compartment.

to keep out the rain and snow, and, if necessary, these can be covered by sods to maintain an even temperature in the pits.

3. <u>Shed storage</u>.-- (See figure 3, page 8) The shed is built of 2" x 4"'s and 1" shiplap with a tight tar-paper roof. It is 25' long, 9' wide and 8' high with a shanty roof, but has no floor. The shed is divided into six bins 4' x 9', and each of these can be further divided into three compartments 4' x 3' capable of storing one ton samples. Each bin has a 2' x 8' opening, which can be boarded up as filled. Figure 4 shows five bins boarded up, the fourth from the right being open. The shed is not completely weather-tight, but is capable of keeping out rain and snow and direct sunlight.

Preliminary Programme for Coal Research.

1. Exact determination of products and by-products obtained by carbonization of Alberta coals under varying conditions of final temperature, rate of heating, pressure, etc.. A special apparatus for rapid testing of small samples to be constructed and employed.

2, Carbonization tests of non-coking lignites

in continuous inclined retorts. Small retort to be built, capable of handling about 20 lbs. of coal per hour.

3. Study of the gas-producing qualities of Alberta coals on a semi-commercial scale. If, as has been suggested, a bench of gas retorts be installed to supply the University with gas, one retort could be provided with separate gas offtake and purifying apparatus to allow these tests to be made.

4. Standardization of a method for the air-drying of coal, and collection of data with regard to moisture-holding properties of Alberta coals.

5. Colloidal coal.-- Preparation and properties of "colloidal" fuel made from raw, dried and carbonized fuels.

6. Powdered coal.-- Suitability of different coals, either in the raw or treated conditions, for use as powdered fuel.

7. Complete and exact analyses of all solid, liquid and gaseous fuels occurring in the province.

8. Determination of empirical formulae for the evaluation of coals from each field by means of proximate analyses.

9. Study of the weathering properties of Alberta coals with special reference to their storage and handling and liability to spontaneous combustion.

10. Briquetting tests on raw, dried and carbonized coals.

11. House-heating furnaces and heat distribution through houses.

12. Study of coking qualities of, and methods of coking most suited to Alberta coals.

13. Producer gas generators.

14. Water gas plants.

Outline of Screening and Storage Tests as Conducted by the Writer.

1. Chemical analyses of all coals as received, including B.T.U.

2. Equivalency of perforated and bar screens on coals from different fields, using the following perforations as standard:

Size of Coal	Perforations: Through	Over	Size of Coal	Perforations
Lump	All over 3"		Dust	all through $\frac{1}{4}$"
Stove or Egg	3" -	$1\frac{1}{2}$"	Slack	" " $\frac{3}{4}$"
Nut	$1\frac{1}{2}$"-	$\frac{3}{4}$"	Nut Slack	" " $1\frac{1}{2}$"
Pea	$\frac{3}{4}$" -	$\frac{1}{4}$"		

3. The above were run on Run of Mine from the various districts, and at the same time a record kept which showed what the percentage of each of the above was in the different Runs of Mine.

4. Coals as received. Ash analyses were made of each size.

5. While doing the above screening, a test was re-run on the different sizes to determine the amount of breakage made in the handling of the coal; that is, after having determined the proportions of lump, egg, etc., in a certain kind of run of mine, these different grades were then re-screened separately, the results obtained showing how much breakage the coal undergoes in being handled over the screens.

6. Having separated the coal into different sizes, samples of Run of Mine, Lump, Egg, Nut and Pea were next set aside for testing each in open storage, shed storage and pit storage, using the following quantities:

Run of Mine -- 1 ton	::	Nut -- ½ ton	
Lump -- -- ½ ton	::	Pea -- ½ ton	
Egg -- -- ½ ton	::	Screened (Lump & Egg) -- 1 ton	

The above samples are to be screened and re-analyzed at the end of one month, six months, one year and two years to determine slacking, losses in size and change in chemical composition, as well as heat value. Bituminous coals, Run of Mine, are only stored in open storage and chamical analysis taken at the end of first month, sixth month, one year and two years.

7. Evaporation tests under Babcock & Wilcox Boilers, both hand and stoker fired, on different sizes of coal.

NOTE: Pembina Run of Mine, Sample No. 400, was the only coal of those tested which was inspected by a Provincial Mines Inspector and certified by him to be a carload representative of the usual output of the mine.

S U M M A R Y   A N D   C O N C L U S I O N S.

Object of Investigations.

The purpose of Screening and Storage tests as carried out by the writer is to further the development of the coal industry of the Province of Alberta, and to enable the replacement of imported coals in Western Canada by the Alberta product.

The work is being carried out at the University of Alberta under the authority of the Provincial Government and the tests to date are designed to determine the following points:

1. Equivalency tests to standardize the relationship between bar and perforated screens as applied on Alberta coal. No data has been available on this point prior to these investigations.

2. Storage tests to evolve a practical method of storage for the easily disintegrated Alberta coals to enable shipping and storing during slack seasons of the year in the mine, and to permit a wider distribution of the coal.

3. Boiler Trials to assist in determining the best method of utilizing these fuels.

Screening Tests.

The screening tests are included under these separate headings:

(a) Equivalency tests, the results of which are graphically pictured in chart no. 4. The Pembina coal (curve C.) gave remarkable results in that the spacing of the bar screens is two-thirds the diameter of the perforations of the plates to produce the same weight of screened coal. This curve C is very close to an average of those of the other three coals. These figures apply to Edmonton Domestic coals.

(b) Percentages of Sizes in Run of Mine, the results of which are given in chart no. 5. The high percentage of screened coal (lump plus egg) is desirable in Domestic coals, but not necessarily so in Steam coals(Cadomin.)

(c) Breakage losses due to Screening and Rehandling, are summed up in chart no. 6. Little can be attached to these results as yet, due to the appreciable disintegration of the coals in the dry, steam-heated Mining Laboratory while waiting between screening and later tests. It shows, though, the higher loss on the weaker or higher moisture coals.

Storage.

Proper means of storage can only be attained after a properly directed study and series of experiments have been conducted on the coals which are to be stored. The present tests are conducted on very small lots and the writer would recommend the coal operators to carry on open storage tests of their own on larger piles of coal than are possible in the tests conducted at the University. Charts 7, 8 and 9 show results of storage on local Domestic coals over a short period of time. The following conclusions are temporarily presented in the light of these results.

1. Greater disintegration occurs as a result of the wetting, drying and freezing of spring weather as compared to the cold, even temperature of winter. (See chart 9, and compare the greater deterioration in Twin City coal over Humberstone.)

2. Shed storage shows less disintegration than open or pit storage in nearly every case. The chemical analysis and calorific value show little change in the first two months of shed storage, but show a slight depreciation in open and pit storage.

3. The smaller sizes of screened coal show much less

deterioration and weakening than the larger.

4. Ash shows higher percentage in smaller sizes of coal.

Boiler Trials.

Charts 21 and 21a are plotted from the table below of important results of Boiler Trials. On page 49 is given a list of coals tested, and date of trials. Most of the coal was tested within a short time after mining.

Important Results of Boiler Trials

Kind of Coal	Humberstone		Twin City		Pembina		Cadomin
Test No.	B-4	B-5	B-7	B-8	B-9	B-10	B-12
Fired by--	Hand	Stoker	Hand	Stoker	Hand	Stoker	Hand
Cal. Value of Fuel as fired B.T.U. per lb.	8900	8150	9310	8980	8800	8500	12570
Total Coal fired (Wet)	12551	16839	12177	12680	10800	12738	7200
Ash, Clinker & Refuse	1187	3266	886	1386	2086	2860	1326
Hourly Evap. (Equiv) 212°F	8430	10390	8210	8725	7368	8777	7441
Water Evap'n per lb. Coal (Actual)	4.97	4.6	5.035	5.18	5.04	5.09	7.72
Equiv. Evap'n per lb. Coal From & at 212°F	5.37	4.93	5.38	5.51	5.46	5.51	8.27
Efficiency of Boiler and Furnace %	58.4	58.3	55.8	59.4	60.6	62.6	63.6
H.P. developed per hour	244	301	238	253	214	254	215

SAMPLING.

Definition.

Sampling is the process of reducing the size of an original lot of ore to a conveniently small representative portion suitable for chemical analysis and other tests.

Need of Care in Sampling.

On page 30 is given a table showing the numbering of samples required from one coal. This table shows the large number of samples that are required in these tests, and as a large portion of the time required in the laboratory work was spent in sampling its importance then in these investigations should be clear.

The technically-trained man is apt to overlook the fact that the average person not so trained is usually entirely ignorant of the need of care in sampling. This fact, however, has been forcibly brought to the writer's notice in recent months in the associations in the Provincial Industrial Laboratories, where, daily, samples of ore and coal are received which are not representative, but are picked samples, and consequently when analyzed not only give an incorrect estimation of the ore body

or seam from which they have been taken, but are also extremely misleading because they indicate a very much richer prospect than is actually the case. The analysis made on these samples may be as accurate as possible, but yet have no real value for the purpose of determining the average quality of the ore body or seam from which they have been taken. The accuracy of the sampling should be within the accuracy possible in the chemical analysis.(1)

The Process of Sampling.

The following summary of sampling is for the most part taken from the publications of the U. S. Bureau of Mines (2), to which the writer has been chiefly indebted for guidance in this respect.

The gross sample has usually been obtained by taking portions of the mass as the coal is being transferred from one carrier to another, the Run of Mine sample being collected by shovelfuls as the coal was being unloaded at the Mining Laboratory and University Power Plant, No. 2, from waggons.

---

(1) Holms, J.A., "The Sampling of Coal in the Mine," Technical Paper No.1, U.S.Bureau of Mines, 1918, p.5.

(2) Pope, G.S., "Methods of Sampling Delivered Coal," Bulletin No.116, U.S.Bureau of Mines, 1918.

The screened coal samples were set aside as the coal was being handled over the screens. The reduction of the gross sample consisted of crushing, mixing, coning and quartering as outlined very clearly in figure 5 (see **next page**) taken from a report of the U. S. Bureau of Mines ([1]). Figure 6 shows

Fig. 6.-- Sampling Mine Run by Coning and Quartering Method on Mixing Sheet. Pile just flattened and quartered.

the sample just quartered, ready for opposite quarters to be discarded, the remainder left on the mixing sheet to be re-crushed, mixed by rolling on

---

([1]) Pope, G.S., "Directions for Sampling Coal for Shipment or Delivery," Technical Paper No. 133, U. S. Bureau of Mines, 1917.

Fig. 5.

METHOD OF PREPARING A SAMPLE OF COAL BY HAND. THE NECESSARY TOOLS ARE A SHOVEL, TAMPER, BLANKET MEASURING ABOUT 6 BY 8 FEET, BROOM, AND RAKE. THE COAL IS RAKED WHILE BEING CRUSHED, SO THAT ALL LUMPS WILL BE CRUSHED. FLOOR OR BLANKET IS SWEPT CLEAN OF DISCARDED COAL EACH TIME AFTER SAMPLE IS HALVED OR QUARTERED.

sheet and again quartered till a two pound sample of $\frac{1}{4}$" size only is retained. This sample is then weighed and air-dried for twenty-four hours at room temperature. The loss on air-drying being obtained, the sample is further crushed and reduced, and then finally ground to about 80 mesh in a pulverizer, about 50 grams of the pulverized coal being quickly put in an air-tight glass bottle and labelled. (See Table, page 30, for numbering.) The air-drying has the twofold purpose of, firstly, allowing the coal to be in a dry enough state for grinding, and, secondly, reducing the danger of losses in moisture due to pulverizing and subsequent re-handling.

SCREENING TESTS.

INTRODUCTION.

Confusion exists between the producer and consumer regarding the sizing and qualities of Alberta coals. It is the purpose then of these screening tests to first screen the coal into standard sizes according to the table as given on page 12, item 2, and, secondly, to determine the equivalency of the bar screens in terms of the standard perforated screens. It may be pointed out that different coals will not have the same equivalency, due to coals in different localities naturally disintegrating into differently shaped blocks. For example, the local (Edmonton) Domestic coal forms almost perfect cubes, while the coals from the Kootenay formation in southern Alberta break into rectangular flat pieces which would give a larger percentage through the bar screens of the same spacing as used on the local Domestic coal. Results are thus reported for each district.

Carload lots of each sample of coal have been received which give approximately for each test

the amounts indicated on the flow sheet, page 29. The present capacities of the laboratories, power plant and storage facilities are taxed to the utmost to handle efficiently these amounts, but it is felt by the Mining Engineering staff that coal in smaller lots would not permit results of a

Fig. 7.-- Coal Screen, Jig and Wifley Table For Coal and Ore Treatment.

practical nature to be ascertained.

Description of Screening Operations.

The screening is being done over a small Marcus shaker screen (see figures 1 and 7.), and the process is as follows:

Approximately thirteen tons of run of mine

are unloaded in the Mining Engineering building. A sample for chemical analysis is taken of this by saving a shovelful at intervals as the coal is unloaded. The gross sample of some 500 lbs. thus obtained is crushed, coned and quartered as explained under sampling above (see page 21). Ten tons is then weighed and screened by barrow loads in the following manner:

Each barrow loaded is weighed and screened over 1½" and 3" perforated plates on the screen. The lump is over size and is collected in a wheelbarrow and weighed. The Egg coal, (over 1½" and through 3") is collected in a box and weighed, as is the Nut Slack (through 1½" perforations). The latter is set aside for re-screening as outlined below.

Let W, w_1, w_2 and w_3 be the total weights respectively of mine run, lump, egg and nut slack, then $\frac{w_1}{W} \times 100$, $\frac{w_2}{W} \times 100$ and $\frac{w_3}{W} \times 100$ are respectively the percentages of lump, egg and nut slack in the run of mine.

The nut slack is rescreened in the same manner over ¼" and ¾" perforated plates. (See flow sheet,

page 29.) Let w_4, w_5 and w_6 be the respective weights of nut (over $\frac{3}{4}$"), pea (over $\frac{1}{4}$" and through $\frac{3}{4}$") and dust coal so screened, then $\frac{w_4}{W}$ x 100, $\frac{w_5}{W}$ x 100 and $\frac{w_6}{W}$ x 100 are respectively the percentages of nut, pea and dust in run of mine. From the above, $\frac{w_1 + w_2}{W}$ x 100 is the percentage of screened coal in run of mine.

During screening care is taken to get an average sample of each size so obtained for chemical analysis. This is done by saving a small portion of each product after the screening of each wheelbarrow load. The gross sample is then crushed, coned and quartered in the usual manner. (See figure 8 for piles of screened coal and collected sample in boxes adjacent to respective size; following page.)

The screened coal is then weighed out in half ton lots and placed in storage. (See figures 1, 2 and 3 above.) The flow sheet and explanatory table (See pages 29 and 30 .) show the quantities of different sizes and sample number for each such storage lot.

The breakage losses due to screening and handling are then determined by screening a half ton

of each size and the percentage loss calculated, e.g., 1000 lbs. of lump, unscreened, produce 800 lbs. lump, 150 lbs. egg and 50 lbs. nut slack, showing a 200 lbs. loss of lump on 1000 lbs., or a 20 per cent. loss. This screening loss is then deducted from the screening loss after various periods of

Fig. 8.-- Screened Coal before Storage:
Left to right: Nut Slack, Egg, Lump, Run of Mine; also boxes containing samples of respective sizes.

time in storage, and the net loss so obtained has then been produced by the deterioration of the coal due to weathering in storage.

The equivalency of the bar screens is then determined by trying different spacings of the

bar screens to find those which give as nearly as possible the same percentage of sizes in Run of Mine as those obtained over the standard perforated plates.

List of Coals Tested.

Name	Sample Number	Locality	Type of Coal	Date Received
Cadomin	100	Layland (G.T.P. Coal Branch)	Bituminous Coking	Nov.8,1920
Humberstone	200	Edmonton Clover Bar	Domestic	Dec.15,1920
Twin City	300	Edmonton	Domestic	Jan.21,1921
Pembina	400	Evansburg	Domestic	Feb.26,1921

F L O W S H E E T O F T E S T S (Coal Sample #400)

MINE RUN, 60000#

Inspected & shipped.

- Mining Laboratory for Screening tests 26000#
  - Equivalency tests 6000#
  - Screening & storage tests, over $1\frac{1}{2}$" & 3" screens 20000#
    - LUMP over 3" screen e.g. 8500# = 42.5%
      - Loss or Breakage on screening 1000#
      - Open storage 1000# (410_o)
      - Pit storage 1000# (410_p)
      - Shed storage 1000# (410_s)
      - 500# (410)
      - 3000#
    - EGG through 3" over $1\frac{1}{2}$", e.g. 6000#=30%
      - 3000#
      - 500# (420)
      - Open storage (420_o)
      - Pit storage (420_p)
      - Shed storage (420_s)
      - Loss on screening
    - Mixed (3000# LUMP + 3000# EGG)
      - Open storage
      - Pit storage
      - Shed storage
    - NUT SLACK through $1\frac{1}{2}$" screen, e.g. 27.5%
      - Rescreened through $\frac{1}{4}$" & $\frac{3}{4}$" perforated screens
        - NUT COAL through $1\frac{1}{2}$" over $\frac{3}{4}$"
          - Open storage 1000# (430_o)
          - Pit storage 1000# (430_p)
          - Shed storage 1000# (430s)
          - Loss on screening 1000#
          - (430)
        - PEA COAL through $\frac{3}{4}$" over $\frac{1}{4}$"
          - (440)
          - Open storage 1000# (440_o)
          - Pit storage 1000# (440_p)
          - Shed storage 1000# (440s)
          - Loss on screening 1000#
        - DUST through $\frac{1}{4}$"
          - Washing tests on Wilfley Table & Jig (450)
- University Power Plant #2 30000#
  - Hand-fired boiler test 12-16000# (400_{B-8})
  - Stoker-fired boiler test 14-18000# (400_{B-9})
- Storage 3000#
  - Open 1000# (400_o)
  - Pit 1000# (400_p)
  - Shed 1000# (400_s)
- 1000# (400)

TABLE to Show How Coal Sample Number Is Obtained From the Tests That Have Been Applied to Sample.

(The Sample Numbers in Flow Sheet thus refer to samples for chemical analysis. These are the numbers in brackets.) The Sample Numbers given below are those for the 4th coal received for Testing.

Size of Coal	Method of Storing	Sample Number				
		As received	After storage for			
			1 mo.	6 mos.	1 yr.	2 yrs.
Mine Run		400				
	Open		401_o	402_o	403_o	404_o
	Pit		401_p	402_p	403_p	404_p
	Shed		401_s	402_s	403_s	404_s
Lump		410				
	Open		411_o	412_o	413_o	414_o
	Pit		411_p	412_p	413_p	414_p
	Shed		411_s	412_s	413_s	414_s
Egg		420	421	422	423	424
Nut		430	431	432	433	434
Pea		440	441	442	443	444
Dust		450	451	452	453	454
Screened Coal = Lump - Egg		460	461	462	463	464

Egg, Nut, Pea, Dust and Screened Coal are numbered as shown in detail for Mine Run and Lump, e.g., Nut in shed storage 1 month would have Sample No. 431_s.

Results on each Coal.

Cadomin:

(a) Equivalency Tests.

Size of Coal	Standard Perforated Screens: Through	Over	Equivalent Bar Screens: Through	Over
Lump	--	3"	--	2"
Egg or Stove	3	$1\frac{1}{2}$	2	$\frac{3}{4}$
Nut	$1\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{1}{2}$
Pea	$\frac{3}{4}$	$\frac{1}{4}$	$\frac{1}{2}$	less than $\frac{1}{4}$
Dust	$\frac{1}{4}$	--	Less than $\frac{1}{4}$	--
Nut Slack	$1\frac{1}{2}$	--	$\frac{3}{4}$	--
Slack	$\frac{3}{4}$	--	$\frac{1}{2}$	--

(From table above it is seen equivalencies were found for all sizes except pea and dust. From the screening data the following bar screens would give practically the same per cent. of pea and dust in Cadomin coal as the standard perforated screens)

Pea	$\frac{3}{4}$"	$\frac{1}{4}$"	$\frac{1}{2}$"	3/16"
Dust	$\frac{1}{4}$	--	3/16	--

(b) Percentages of Standard Sizes in Run of Mine.

Size	Percentage
Lump	14.0
Egg or Stove	16.4
Nut	10.1
Pea	23.9
Dust	35.8
Total	100.2

Size	Percentage
Screened Coal	30.4
Nut Slack	69.8
Slack	59.7

(c) Breakage Losses Due to Screening.

1. Lump: 88 lbs. loss on 544 lbs., or 16.2%.

2. Egg: 219 lbs. loss on 513 lbs., or 30.10%

HUMBERSTONE:

(a) Equivalency Tests.

Size of Coal	Standard Perforated Screens: Through	Over	Equivalent Bar Screens: Through	Over
Lump	--	3"	--	2"
Egg or Stove	3	$1\frac{1}{2}$	(not determined)	
Nut	$1\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{1}{2}$
Pea	$\frac{3}{4}$	$\frac{1}{4}$	$\frac{1}{2}$	less than $\frac{1}{4}$
Dust	$\frac{1}{4}$	--	less than $\frac{1}{4}$	--
Nut slack	$1\frac{1}{2}$	--	$\frac{3}{4}$	--
Slack	$\frac{3}{4}$	--	$\frac{1}{2}$	--

(No Lump coal was received for this test. The following bar screen spacing would give practically an equivalency for Pea and Dust sizes above.)

Pea	$\frac{3}{4}$"	$\frac{1}{4}$"	$\frac{1}{2}$"	3/16"
Dust	$\frac{1}{4}$	--	3/16	--

(b) Percentages of Standard Sizes in Run of Mine.

This coal was received in three sizes, so percentages of sizes in Run of Mine was not determined.

(c) Breakage Losses due to Screening.

1. Egg: 207 lbs. loss on 653 lbs., or 31.7%
2. Nut: 30 lbs. loss on 224 lbs., or 13.4%
3. Pea: 15.5 lbs. loss on 394.5 lbs., or 3.9%

TWIN CITY:

(a) Equivalency Tests.

Size of Coal	Standard Perforated Screens: Through	Over	Equivalent Bar Screens: Through	Over
Lump	--	3"	--	greater than 2"
Egg or Stove	3"	$1\frac{1}{2}$"	greater than 2"	less than $\frac{3}{4}$"
Nut	$1\frac{1}{2}$"	$\frac{3}{4}$"	less than $\frac{3}{4}$"	greater than $\frac{1}{2}$"
Pea	$\frac{3}{4}$"	$\frac{1}{4}$"	greater than $\frac{1}{2}$"	less than $\frac{1}{4}$"
Dust	$\frac{1}{4}$"	--	less than $\frac{1}{4}$"	--
Nut Slack	$1\frac{1}{2}$"	--	$\frac{3}{4}$	--
Slack	$\frac{3}{4}$	--	$\frac{1}{2}$	--

(The following bar screen spacing would give approximate equivalency here.)

Size	Through	Over	Size	Through	Over
Lump	--	2-1/8"	Dust	3/16"	--
Egg	2-1/8"	$\frac{3}{4}$"			
Nut	$\frac{3}{4}$"	9/16"	Nut Slack	$\frac{3}{4}$"	--
Pea	9/16"	3/16"	Slack	9/16"	--

(b) Percentages of Standard Sizes in Run of Mine.

Lump	44.6)	Screened Coal	74.5%
Egg or Stove	29.9)		
Nut	10.2%	Nut Slack	25.5%
Pea	10.7%		
Dust	4.6%	Slack	15.3%
Total	100.0%		

(c) Breakage Losses Due to Screening.

1. Lump: 163 lbs. loss on 900 lbs., or 18.1%
2. Egg: 188 lbs. loss on 937.5 lbs., or 20.1%
3. Nut: 48.5 lbs. loss on 357.5 lbs., or 11.9%
4. Pea: 15.5 lbs. loss on 394.5 lbs., or 3.9%

PEMBINA: (a) Equivalency Tests.

Size of Coal	Standard Perforated Screens: Through	Over	Equivalent Bar Screens; Through	Over
Lump	--	3"	--	2"
Egg or Stove	3	$1\frac{1}{2}$	2	1
Nut	$1\frac{1}{2}$	$\frac{3}{4}$	1	$\frac{1}{2}$
Pea	$\frac{3}{4}$	$\frac{1}{4}$	$\frac{1}{2}$	1/6
Dust	$\frac{1}{4}$	--	1/6	--
Nut Slack	$1\frac{1}{2}$	--	1	--
Slack	$\frac{3}{4}$	--	$\frac{1}{2}$	--
Extras(1)	--	2	--	1-1/3
(2)	2	1	1-1/3	2/3
(3)	1	--	2/3	--

Note:-- The Bar Screens to give an equivalency in Pembina coal have a spacing 2/3 that of the perforated screens in each case. In Domestic coals, Clover Bar seam, this is only so in the case of Lump.

(b) Weights and Percentages of Standard Sizes in Run of Mine.

Size	Total lbs. Screened.	Percentage of R.O.M.	
R.O.M.	19594.5	100.0	
Lump	8509.5	43.4	= A
Egg	3863.5	19.7	= B
Nut	7221.5	11.4	= C
Pea		16.4	= D
Dust		9.1	= E
Total...	19594.5	100.0	
Screened Coal	12373.0	63.1	= F
Nut Slack ...	7221.5	36.9	= G
Total...	19594.5	100.0	
Slack		25.5	= H

Note.-- (A + B)=F, (C+D+E)=G and (D+E)=H. (Amounts of coal screened are given in this one case only to show how results are obtained.)

(c) Breakage Losses Due to Screening.

1. Lump: 210.5 lbs. loss on 1425.5 lbs., or 14.8%
2. Egg: 213 lbs. loss on 1149.0 lbs., or 18.5%
3. Nut: 100.5 lbs. loss on 823.5 lbs., or 12.2%
4. Pea: 18.5 lbs. loss on 421.0 lbs., or 4.3%

Conclusions on Screening Tests.

As is pointed out in the case of Pembina coal the required spacing for bar screens to approximately produce the same percentage by weight of sized coal as from the perforated plates is two-thirds the diameter of the perforations. For example, a 2" spaced bar screen is equivalent to a 3" perforated plate. This in general applies to all four coals tested above. (See chart no. 4.)

There is little to be inferred from the results on item (b) -- percentages of standard sizes in Run of Mine -- (See also chart no. 5) except that a higher percentage of screened coal indicates an increased desirability of that coal for domestic purposes, due to the fact that the highest price is paid for the larger sizes.

The first coal tested above has only 30.4% screened coal, which would make it difficult for that coal to compete with the fourth coal tested for domestic purposes, This does not mean, however, that the former coal is inferior for other purposes, it being a high grade bituminous coking coal and an excellent steam coal. (See chart no. 20 of Boiler Trial B-12.)

From a comparison of the breakage losses due

to screening (See chart No. 6) the relative strength of the various coals could be roughly estimated, for example the first and fourth samples tested show less percentage breakage loss, so it is fairly safe to assume that these two coals would stand shipment by rail to better advantage than the other two coals. Drying out of the high moisture Domestic coals has a very great tendency to render the lumps tender, as is evidenced by the screening tests on Humberstone Egg before and after storing. (See chart no. 9) The breakage losses due to rehandling and rescreening were taken on coal stored in the Mining Laboratory for a few days, and show that the coal is broken up much more by drying out for a few days than by open or other storage for a few weeks. After this experience with screening losses the effort has been made to store the coal and get the breakage loss as soon as the coal is screened, with much better effect, as can be seen by comparing Humberstone and Twin-City coals. (See chart no. 9)

STORAGE TESTS.

Review of Previous Investigations.[1][2]

The writer wishes to call attention to a recent work [1] published by the University of Illinois on "Bituminous Coal Storage Practice." This work was published as a result of the coal shortage in the United States during the winter of 1917-18, when in time of stress lack of stored coal was a serious matter, and when improperly stored coal gave considerable trouble due to spontaneous combustion; most of which could have been avoided were proper precautions taken in storing. This is a valuable report in that it includes a review of the practice as carried out by over five hundred individuals, manufacturing concerns, railroads, coke plants and power plants, who stored coal under widely different conditions.

To apply the conclusions reached by Stoek, Hippard, and Langtry to our particular problem in Alberta it is

(1) Stoek, H.H., Hippard, C.W. and Langtry W.D.: "Bituminous Coal Storage Practice," Bulletin No. 116, Eng. Experiment Station, University of Illinois, Jan. 1920.

(2) Porter, J.B.: "Weathering of Coal," Mines Branch, Canada, Extra Vol. Report 83, 1915.

necessary to state that there are three essentials lacking in the present coal industry of this Province:

1. The usual heavy shipments of coal in the fall of the year occur when every available freight car is needed to move grain. This congestion of traffic prevents an adequate steady supply of coal to consumers in Alberta, Saskatchewan, Manitoba and Western Ontario, the natural market for Alberta coal.

2. Production as it is now is spasmodic and uncertain, many mines only running part of the year.

3. The market for Alberta coal is now just beginning to be extended to eastern points, and is waiting on education and knowledge of methods of storing Alberta coal. Proper storing then would enable the coals to be shipped during the slack season of the railways and enable the mines to remain open the year around, to the undoubted benefit of operator, miner and railways, as well as ensuring the consumer of a normal supply of fuel.

The following points should be noted before anyone attempts to store coal in large quantities, though for household use, etc., they are not important.

1. Have suitable place prepared for storage by

attending to drainage, leveling of ground to avoid dirt in reclaiming. Avoid storing next to fences, chimney stacks, refuse, hot walls or above flues.([1]) A slight rise in temperature is followed by a much greater increase in the danger of spontaneous combustion.

2. Store the coal between the 1st of May and the 1st of September to avoid difficulties of transportation, and to equalize the mining industry, care being taken to combat the heating of the coal if stored at a high temperature.

3. Fine coal, Mine Run, etc., should be stored in low piles.

4. Sulphur in Alberta coals ranges from 0.2% to 1% ([2]) and very seldom above 0.6%. This small amount would not be likely to affect storing.

5. Clean screened coal should be stored in accessible piles, any part of which can be removed in case of overheating.([3]) Conical piles are dangerous since the fine coal tends to segregate in the centre

([1]) Bulletin 116, University of Illinois, pp.66,68,70,71,72

([2]) Stansfield, E.:"Analysis of Canadian Fuels," Part IV., & Nicolls, J.H.H. : Mines Branch, Canada, 1918.

([3]) Bulletin 116, University of Illinois, p. 108.

causing excessive ventilation through the outside of the pile and insufficient ventilation through the fine coal at the centre, a condition very likely to produce spontaneous combustion.

6. Repeated wetting and drying considerably increases the disintegration of the coal, as has been noted in the case of the high moisture coals.(See page 36.) This produces more fines and so increases liability to spontaneous combustion.

7. Great care should be taken to keep the stored coal free from such inflammable material as waste, paper, rags, wood, tar and oil. These form the nucleus, usually, from which fires start.

8. The more coal stored in one place, the greater the need of attention to the above points in storing, care being especially taken for the first few weeks of storage. Porter (1) says that, in addition to the above precautions, individual coals must be individually studied in order to reach a practical method of safe storing. He also advises the use of hollow iron pipes driven into the pile at intervals in which to insert thermometers to watch the rise in temperature due to the heating of the coal.

(1) See (2), page 37.

Description of Tests.

There is little to add to what has already been written on "Storage" on pages 8 to 10, and item 6, on page 13. The work has been carried out according to this outline and tests made on Humberstone and Twin City coals before and after one and two months storage respectively.

Tables on pages **43**,and **45** show the chemical analyses before and after storing.

Chart No. 9 shows comparison of breakage losses before and after storage.

Charts Nos. 7 & 8 on Humberstone and Twin City coals respectively show the chemical analyses before and after storage.

(a) Breakage Losses Before and After Storage.

HUMBERSTONE:	Breakage %			
	Before	After		
		Open	Pit	Shed
Egg	31.7	18.4	25.9	22.1
Nut	13.4	13.9	22.8	18.6
Pea	3.9	4.8	9.4	8.8
TWIN CITY:				
Lump	18.1	47.0	35.4	34.5
Egg	20.1	48.5	45.7	43.5
Nut	11.9	32.2	36.7	25.2
Pea	3.9	(Not stored. Used for Washing Tests.)		

HUMBERSTONE: Chemical Analysis as Received.

Size	Egg		Nut		Pea	
Sample No.	220		230		240	
Condition	As Rec'd	Air Dried	As Rec'd	Air Dried	As Rec'd	Air Dried
Loss on A.D.	3.6	--	4.6	--	5.4	--
Moisture	19.5	16.6	21.2	17.4	22.3	17.9
Vol. Matter	33.2	34.5	30.7	32.2	30.4	32.1
Ash	9.0	9.2	8.8	9.2	10.5	11.1
Fixed Carbon	38.3	39.7	39.3	41.2	36.6	38.9
Calories per gram.	4954	5138	4770	5000	4510	4873
B.T.U.per lb	8920	9250	8590	9000	8210	8780

CADOMIN: Chemical Analysis of Run of Mine, As Received and After One Month in Open Storage.

Sample No.	100		101_0	
Condition	As Rec'd	Air Dried	As Rec'd	Air Dried
Loss on A.D.	2.2	--	3.3	--
Moisture	3.7	1.5	4.3	1.0
Vol. Matter	25.4	36.0	24.1	26.0
Ash	10.4	10.6	12.0	12.4
Fixed Carbon	60.5	61.9	58.6	60.6
Calories per gram.	7377	7541	7095	7333
B.T.U.per lb	13280	13570	12770	13200

HUMBERSTONE: Storage Table.

Egg.

Sample No.	220		221o		221p		221s	
Condition	As Rec'd	Air Dried	As Rec'd	Air Dried	As Rec'd	Air Dried	As Rec'd	Air Dried
Loss on Air Drying	3.6	--	6.9	--	3.6	--	10.0	--
Moisture	19.4	16.6	23.2	17.5	23.2	20.4	20.3	11.2
Vol.Matter	33.2	34.5	28.0	30.1	29.1	30.2	29.7	33.0
Ash	9.0	9.2	11.9	12.8	10.3	10.7	10.5	11.7
Fixed Carbon	38.3	39.7	36.8	39.6	37.3	38.7	39.6	44.1
Cal.per gm	4954	5138	4737	5088	4925	5107	4886	5428
B.T.U " lb	8920	9250	8520	9160	8860	9190	8790	9770

Nut

Sample No.	230		231_o		231_p		231_s	
Condition	As Rec'd	Air Dried	As Rec'd	Air Dried	As Rec'd	Air Dried	As Rec'd	Air Dried
Loss on Air Drying	4.6	--	3.8	--	2.6	--	8.5	--
Moisture	21.2	17.4	22.6	19.5	20.3	18.2	17.7	10.0
Vol.Matter	30.7	32.2	28.8	30.0	30.0	30.8	30.3	33.1
Ash	8.8	9.2	10.0	10.4	10.1	10.4	11.3	12.4
Fixed Carbon	39.3	41.2	38.6	40.1	39.6	40.6	40.7	44.5
Cal.per gm	4770	5000	4760	4951	4935	5065	5324	5819
B.T.U." lb	8590	9000	8570	8910	8880	9120	9590	10470

Pea

Sample No.	240		241o		241p		241s	
Condition	As Rec'd	Air Dried	As Rec'd	Air Dried	As Rec'd	Air Dried	As Rec'd	Air Dried
Loss on Air Drying	5.4	--	4.2	--	6.2	--	10.6	--
Moisture	22.3	17.9	24.9	21.4	22.8	17.7	24.4	15.4
Vol.Matter	30.4	32.1	27.0	28.9	32.5	34.7	27.8	31.1
Ash	10.5	11.1	10.5	10.9	10.4	11.1	11.1	12.4
Fixed Carbon	36.6	38.9	37.6	39.8	34.2	36.5	36.7	41.1
Cal.per gm	4610	4873	4800	4954	4590	4886	4665	5213
B.T.U." lb	8310	8780	8630	8920	8260	8790	8390	9380

TWIN CITY: Chemical Analysis as Received.

Size	Run of Mine.		Lump.		Egg.	
Sample No.	300		310		320	
Condition	As Rec'd	Air Dried	As Rec'd	Air Dried	As Rec'd	Air Dried
Loss on A.D.	4.7	--	3.7	--	3.4	--
Moisture	22.1	18.3	20.0	17.1	21.7	19.0
Vol. Matter	29.2	30.6	30.0	31.5	30.1	31.2
Ash	6.3	6.6	7.2	7.5	6.6	6.8
Fixed Carbon	42.4	44.5	42.8	43.9	41.5	43.0
Cal. per gm.	5151	5405	5065	5315	5231	5415
B.T.U.per lb	9270	9730	9120	9570	9420	9760

Size	Nut.		Pea.	
Sample No.	330		340	
Condition	As Rec'd	Air Dried	As Rec'd	Air Dried
Loss on A.D.	2.8	--	2.3	--
Moisture	19.7	17.4	20.7	18.8
Vol. Matter	29.7	30.6	29.6	30.3
Ash	9.4	9.7	9.2	9.4
Fixed Carbon	41.2	42.3	40.5	41.5
Cal. per gm.	5070	5219	4875	4991
B.T.U.per lb	9120	9390	8780	8980

TWIN CITY: Storage Table.

Run of Mine.

Sample No.	300		301_o		301_p		301_s	
Condition	As rec'd	Air Dried	As rec'd	Air Dried	As rec'd	Air Dried	As rec'd	Air Dried
Loss on AD	4.7	--	4.4	--	11.7	--	3.0	--
Moisture	22.1	18.3	21.6	18.0	22.8	12.6	21.0	18.6
Vol.Matter	29.2	30.6	29.8	31.2	29.2	33.0	30.2	31.1
Ash	6.3	6.6	9.3	9.7	8.9	10.1	8.4	8.7
Fixed Carb	42.4	44.5	39.2	41.1	39.1	44.3	40.3	41.6
Cal.per gm	5151	5405	4914	5140	4783	5419	5030	5186
B.T.U." lb	9270	9730	8840	9250	8610	9750	9060	9330

Lump

Sample No.	310		311_o		311_p		311_s	
Condition	As rec'd	Air Dried	As rec'd	Air Dried	As rec'd	Air Dried	As rec'd	Air Dried
Loss on AD	3.7	--	6.0	--	10.1	--	14.5	--
Moisture	20.0	17.1	21.9	16.9	21.1	12.2	20.3	6.8
Vol.Matter	30.0	31.5	30.2	32.2	29.6	33.0	29.9	35.0
Ash	7.2	7.5	6.5	6.9	6.2	6.9	5.8	6.8
Fixed Carb	42.8	43.9	41.4	44.0	43.1	47.9	43.9	51.4
Cal.per gm	5065	5315	5203	5535	5324	5927	5023	5875
B.T.U." lb	9120	9570	9370	9960	9580	10660	9040	10570

Egg

Sample No.	320		321_o		321_p		321_s	
Condition	As rec'd	Air Dried	As rec'd	Air Dried	As rec'd	Air Dried	As rec'd	Air Dried
Loss on AD	3.4	--	5.3	--	14.2	--	3.2	--
Moisture	21.7	19.0	20.8	16.4	24.7	12.2	19.2	16.5
Vol.Matter	30.1	31.2	29.6	31.3	29.5	34.4	28.8	29.8
Ash	6.6	6.8	9.9	10.5	7.4	8.6	9.2	9.5
Fixed Carb	41.5	43.0	39.6	41.8	38.5	44.8	42.8	44.2
Cal.per gm	5231	5415	5019	5300	4738	5521	5103	5272
B.T.U " lb	9420	9760	9030	9540	8530	9940	9190	9490

Nut

Sample No.	330		331_o		331_p		331_s	
Condition	As rec'd	Air Dried	As rec'd	Air Dried	As rec'd	Air Dried	As rec'd	Air Dried
Loss on AD	2.8	--	6.0	--	7.4	--	4.9	--
Moisture	19.7	17.4	20.2	15.1	22.8	16.7	19.7	15.6
Vol.Matter	29.7	30.6	30.2	32.2	29.3	31.7	31.0	32.7
Ash	9.4	9.7	8.1	8.6	9.3	9.9	8.0	8.4
Fixed Carb	41.2	42.3	41.5	44.1	38.6	41.7	41.2	43.3
Cal.pergm	5070	5219	5153	5482	4901	5293	5193	5461
B.T.U." lb	9120	9390	9280	9870	8820	9530	9350	9830

PEMBINA: Chemical Analysis as Received.

Size	Run of Mine.		Lump		Egg	
Sample No.	400		410		420	
Condition	As Rec'd	Air Dried	As Rec'd	Air Dried	As Rec'd	Air Dried
Loss on A.D.	2.5	--	2.7	--	1.4	--
Moisture	16.4	14.3	15.8	13.5	15.9	14.7
Vol.Matter	27.6	28.3	27.8	28.6	28.6	29.0
Ash	13.9	14.2	13.2	13.6	12.8	13.0
Fixed Carbon	42.1	43.2	43.2	44.3	42.7	43.3
Calories per gram.	4854	4981	5024	5160	5155	5228
B.T.U.per lb	8750	8970	9050	9290	9280	9410

Size	Nut		Pea	
Sample No.	430		440	
Condition	As Rec'd	Air Dried	As Rec'd	Air Dried
Loss on A.D.	7.5	--	5.9	--
Moisture	15.6	8.8	15.6	10.3
Vol.Matter	28.9	31.2	29.1	30.9
Ash	11.2	12.1	13.4	14.2
Fixed Carbon	44.3	47.9	41.9	44.6
Calories per gram	5030	5440	4935	5244
B.T.U.per lb	9050	9790	8880	9440

Conclusions.

The tests outlined have not been carried out for a sufficient length of time to allow any definite conclusions to be drawn. The Humberstone storage period was during the winter season and shows much less disintegration than in the case of Twin City coal whose period of storage included a great range of temperature and exposure to much rain and snow followed by a harmful drying out, freezing and thawing.

The following tentative conclusions are drawn from the inspection of the above-mentioned charts.

1. Winter storage has less effect on Domestic coal than the more marked effect due to the wetting and drying and freezing of variable spring weather.

2. Shed storage shows less disintegration than open or pit storage, and practically no change in chemical analysis.

3. Ash is usually higher in the smaller sized coal.

4. The smaller sizes of screened coal show much less deterioration than the larger sizes.

BOILER TRIALS.

Hitherto most of the Boiler Trials conducted on Alberta coals have been done at Ottawa [1], at the Dominion Government Fuel Testing Station, or at McGill University.[2] The coals so tested had to be shipped several thousand miles by rail and undergo frequent handling and delays. The coal so tested was thus greatly handicapped in obtaining a fair trial in comparison with imported and Eastern coals. The Boiler Trials conducted here as a part of the "Preliminary Investigations of Alberta Coals" have been made on coal shipped directly from the tipple to the University Bunker, where it has seldom been stored more than a week or two before being given trial under hand-fired and stoker-fired boilers. The results are therefore based on conditions similar to those within reasonable rail distance of the pit-heads, and should show a comparison of these coals.[3]

(1) Blizard, J.& Malloch, E.S.: "Results of Forty-one Steaming Tests Conducted at Fuel Testing Station, Ottawa." Bulletin.27, Mines Branch, Canada, 1920.

(2) Porter, J.B., Durley, R.J. & others: "Coals of Canada," Report 83, vol.II, Mines Branch, Canada, 1912.

(3) Haanel, B.F. & Blizard, J.: "Results of the Investigation of Six Lignite Samples Obtained from the Province of Alberta," Mines Branch, Canada, Report 331, p.2, 1915.

Charts 21 and 21a are a comparison of seven important results of boiler trials. Charts 14 to 20 inclusive s show the details of readings during the trials.

The trials lasted for 8 hours and were made at the University of Alberta Power Plant No. 2, Edmonton. The type of boilers used was Babcock and Wilcox Water Tube. At the time of writing the market value of some of the coals only has been received.

List of Trials.

Trial No.	Date	Kind of Coal.	Market Value	Page
B-4	Jan.11,1921	Humberstone Nut.	$5.75	50
B-5	Jan.13,1921	" Slack	$3.50	51
B-7	Feb.17,1921	Twin City,R.O.M.		52
B-8	Feb.18,1921	" "		53
B-9	Mar. 3,1921	Pembina, R.O.M.		54
B-10	Mar. 4,1921	" "		55
B-12	Mar.23,1921	Cadomin, R.O.M.		56

EVAPORATION TEST NO. B-4, Jan. 11, 1921.

Builders Rating of Boiler -- 2197 sq. ft. Heating Surface, 44 sq. ft. Grate: 220 h.p.
Method of Firing -- Hand
Kind of Coal Used -- Humberstone Nut.
Cost of Fuel Per Ton at Bunker -- Market Value.... $5.75
Percentage of Moisture.............................. 24.7
Total Coal Fired(Wet)..............................12551 lbs.
Total Coal Fired(Dry).............................. 9451 lbs
Average Coal Consumption Per Hour.................. 1569 lbs.
Ash, Clinker and Refuse............................ 1187 lbs.
Total Combustible.................................. 8264 lbs.

Average Pressure and Temperatures.

Steam Pressure Gauge............................... 146.6
Temperature Feed Water............................. 163.7
Draft over Fire.........Inches of Water.......... 0.74
Barometer...............Inches of Mercury........ 27.58

Water.

Total Water Evaporated at 163.7°F. Coal as Fired..62430
Water Evaporated Per Hour.......................... 7800
Total Equiv.Evap. From and at 212°F...............67450
Hourly Equiv.Evap. from and at 212°F.............. 8430

Economic Results

Water Evaporated Per Pound of Coal(Actual Conditions)4.97
Equiv.Evap. Per lb. Coal(From & at 212°F)......... 5.37
Equiv.Evap. Per lb. Coal(Dry)From & at 212°F...... 7.13
Equiv.Evap. Per lb. Coal(Combustible)From & at 212°F 8.16
Cost of Evaporation per 1,000 lbs. Water.......... 53.5¢
Cost of Steam per H.P. Hour........................ 1.85¢
Factor of Evaporation.............................. 1.081

Efficiency

Efficiency of Boiler and Furnace -- per cent...... 58.4
H.P. Developed Per Hour............................ 244
Percentage of Builders Rating...................... 111

Proximate Analysis of Fuel as Fired.

Fixed Carbon.......... 39.6%
Volatile Matter...... 28.8%
Ash.................. 6.9%
Moisture............. 24.7%

B. T. U. per lb...... 8900

(Sgd.) Charles A. Robb.

EVAPORATION TEST NO. B-5, Jan. 13, 1921.

Builders Rating of Boiler -- 2197 sq. ft. Heating Surface, 60 sq. ft. Grate: 220 h.p.
Method of Firing -- B.& W. Special chain grate, Stoker, close link.
Kind of Coal used -- Humberstone Slack.

Cost of Fuel Per Ton at Bunker -- Market Value ...	$3.50
Percentage of Moisture...........................	22.8
Total Coal Fired(Wet)............................	16839 lbs.
Total Coal Fired(Dry)............................	13000 lbs.
Average Coal Consumption Per Hour................	2105 lbs.
Ask, Clinker and Refuse..........................	3266 lbs.
Total Combustible................................	9734 lbs.

Average Pressure and Temperatures.

Steam Pressure Gauge.............................	149.6
Temperature Feed Water...........................	172.4
Draft over Fire.......... Inches of Water	0.65
Barometer................ Inches of Mercury	27.5

Water

Total Water Evap. at 172.4°F. Coal as Fired......	77500
Water Evaporated Per Hour........................	9690
Total Equiv.Evap.From and at 212°F...............	83100
Hourly Equiv.Evap.From and at 212°F..............	10390

Economic Results

Water Evaporated Per Pound of Coal(Actual Conditions)	4.6
Equiv.Evap.Per lb.Coal(From and at 212°F)........	4.93
Equiv.Evap.Per lb.Coal(Dry)From and at 212°F.....	6.39
Equiv.Evap.Per lb.Coal(Combustible)From & at 212°F	8.54
Cost of Evaporation Per 1,000 lbs. Water.........	35.5¢
Cost of Steam Per H.P.Hour.......................	1.22¢
Factor of Evaporation............................	1.072

Efficiency

Efficiency of Boiler and Furnace -- per cent.....	58.3
H.P. Developed Per Hour..........................	301
Percentage of Builders Rating....................	137

Proximate Analysis of Fuel as Fired.

Fixed Carbon.........	37.2%
Volatile Matter......	26.7%
Ash..................	13.4%
Moisture.............	22.8%

B. T. U. per lb...... 8150

(Sgd.) Charles A. Robb.

EVAPORATION TEST NO. B-7, Feb.17, 1921.

Builders Rating of Boiler -- 2197 sq.ft.H.S. 44 sq.ft. Grate area, 220 H.P.
Method of Firing -- Hand. Dutch Oven.
Kind of Coal Used -- Twin City, Run of Mine.

Percentage of Moisture........................	22.3
Total Coal Fired(Wet).........................	12177
Total Coal Fired(Dry).........................	9462
Average Coal Consumption Per Hour............	1522
Ash, Clinker and Refuse.......................	886
Total Combustible.............................	8576

Average Pressure and Temperatures

Steam Pressure Gauge..........................	145.6
Temperature Feed Water.in.Degrees.F..........	172.7
Draft over Fire.......Inches of Water.......	.40
Barometer.............Inches of Mercury.....	28.0
CO_2..	7.5
Temperature of flue gas Ave.Degrees F.......	549

Water

Total Water Evaporated at 172.7°F.Coal as Fired	61360
Water Evaporated Per Hour....................	7670
Total Equiv.Evap.From and at 212°F..........	65600
Hourly Equiv.Evap.From and at 212oF.........	8210

Economic Results

Water Evaporated Per lb.Coal(Actual Conditions)	5.035
Equiv.Evap.Per lb.Coal From and at 212°F....	5.38
Equiv.Evap.Per lb.Coal(Dry)From and at 212°F	6.94
Equiv.Evap.Per lb.Coal(Combustible) " 212°F	7.64
Cost of Evaporation per 1,000 lbs. Water....	-----
Cost of Steam per H.P.Hour..................	-----
Factor of Evaporation........................	1.070

Efficiency

Efficiency of Boiler and Furnace............	55.8
H.P. Developed Per Hour......................	238
Percentage of Builders Rating...............	108

PROXIMATE ANALYSIS OF FUEL AS FIRED.

Fixed Carbon...........	40.9%
Volatile Matter........	28.7%
Ash....................	8.1%
Moisture...............	22.3%

B. T. U. per lb....... 9310

(Sgd.) Charles A. Robb.

EVAPORATION TEST NO. B-8, Feb.18, 1921

Builders Rating of Boiler -- 2197 Sq.Ft. Heating Surface, 60 sq. ft. Grate; 220 H.P.
Method of Firing -- B.& W. special chain grate Stoker, close link.
Kind of Coal Used -- Twin City, Run of Mine.

Percentage of Moisture	23.5
Total Coal Fired(Wet)	12680
Total Coal Fired(Dry)	9700
Average Coal Consumption Per Hour	1585
Ash, Clinker and Refuse	1386
Total Combustible	8314

Average Pressures and Temperatures.

Steam Pressure Gauge	127.1
Temperature Feed Water, Degrees F.	177.9
Draft over Fire.....Inches of Water	.50
Barometer...........Inches of Mercury	28.22
CO_2	6.7
Temperature of Flue Gas Ave.Degrees F.	411

Water

Total Water Evaporated at 177.9°F.Coal as Fired	65739
Water Evaporated Per Hour	8217
Total Equiv.Evap.From and at 212°F.	69800
Hourly Equiv.Evap.From and at 212°F.	8725

Economic Results

Water Evaporated Per Pound of Coal(Actual)	5.18
Equiv. Evap.Per lb.Coal from and at 212°F.	5.51
Equiv.Evap.Per lb.Coal(Dry)From and at 212°F.	7.20
Equiv.Evap.Per lb.Coal(Combustible) " 212°F.	8.4
Cost of Evaporation per 1,000 lbs. Water	----
Cost of Steam per H.P.Hour	----
Factor of Evaporation	1.062

Efficiency

Efficiency of Boiler and Furnace	59.4
H.P. Developed Per Hour	253
Percentage of builders Rating	115

PROXIMATE ANALYSIS OF FUEL AS FIRED:

Fixed Carbon	38.4%
Volatile Matter	29.7%
Ash	8.4%
Moisture	23.5%

B. T. U. per lb....... 8980

(Sgd.) Charles A. Robb.

EVAPORATION TEST NO. B-9, Mar. 3rd, 1921.

Builders Rating of Boiler -- 2197 sq.ft. Heating Surface, 44 sq. ft. Grate Area; 220 h.p.
Method of Firing -- Hand Fired Dutch Oven.
Kind of Coal Used -- Pembina, Mine Run.

Cost of Fuel Per Ton at Bunker................	---
Percentage of Moisture........................	17.2
Total Coal Fired(Wet).........................	10800
Total Coal Fired(Dry).........................	8942
Average Coal Consumption Per Hour.............	1350
Ash, Clinker and Refuse..... 19.3%	2086
Total Combustible.............................	6856

Average Pressures and Temperatures

Steam Pressure Gauge..........................	148.7
Temperature Feed Water, Degrees F.............	162.7
Draft over Fire.....Inches of Water...........	.40
Barometric Pressure.Inches of Mercury.........	27.6
CO_2..	9.0
Temperature of Flue Gas,Ave.,Degrees F........	438

Water.

Total Water Evaporated at 162.7°F.Coal as Fired	54488
Water Evaporated Per Hour.....................	6811
Total Equiv.Evap.From and at 212°F............	58946
Hourly Equiv.Evap.From and at 212°F...........	7368

Economic Results

Water Evaporated Per lb.Coal(Actual Conditions)	5.04
Equiv.Evap.Per lb.Coal from and at 212°F.......	5.46
Equiv.Evap.Per lb.Coal(Dry)from and at 212°F...	6.59
Equiv.Evap.Per lb.Coal(Combustible) " 212°F...	8.59
Cost of Evaporation per 1,000 lbs. Water.......	---
Cost of Steam per H.P.Hour.....................	---
Factor of Evaporation..........................	1.082

Efficiency

Efficiency of Boiler and Furnace..............	60.6
H.P. Developed Per Hour.......................	214
Percentage of Builders Rating.................	97

PROXIMATE ANALYSIS OF FUEL AS FIRED.

Fixed Carbon.........	41.6%
Volatile Matter......	26.7%
Ash..................	14.5%
Moisture.............	17.2%

B. T. U. per lb...... 8800

(Sgd.) Charles A.Robb,

EVAPORATION TEST NO. B-10, Mar. 4th, 1921

Builders Rating of Boiler -- 2197 sq.ft. Heating Surface, 60 sq. ft. Grate Area; 220 H.P.
Method of Firing -- B.& W. special chain grate Stoker close link.
Kind of Coal Used -- Pembina, Run of Mine, cracked fine.

Cost of Fuel Per Ton at Bunker................	---
Percentage of Moisture....................	16.9
Total Coal Fired(Wet)......................	12738
Total Coal Fired(Dry)......................	10585
Average Coal Consumption Per Hour..............	1592
Ash, Clinker and Refuse......................	2860
Total Combustible.........................	7725

Average Pressures and Temperatures

Steam Pressure Gauge.......................	150.6
Temperature Feed Water.Degrees F..............	163.5
Draft over Fire....Inches of Water............	.40
Barometer..........Inches of Mercury..........	27.65
CO_2.......................................	6.8
Temperature of Flue Gas,Ave.Degrees F.........	417

Water

Total Water Evaporated at 163.5°F,Coal as Fired	64897
Water Evaporated Per Hour....................	8112
Total Equiv.Evap.From and at 212°F............	70218
Hourly Equiv.Evap.From and at 212°F............	8777

Economic Results

Water Evaporated Per Pound of Coal(Actual)....	5.09
Equiv.Evap.Per lb.Coal From and at 212°F......	5.51
Equiv.Evap.Per lb.Coal(Dry)From and at 212°F..	6.63
Equiv.Evap.Per lb.Coal(Combustible)F" 212°F..	9.09
Cost of Evaporation per 1,000 lbs. Water......	---
Cost of Steam per H.P.Hour..................	---
Factor of Evaporation........................	1.082

Efficiency

Efficiency of Boiler and Furnace..............	62.6
H.P. Developed Per Hour.....................	254
Percentage of Builders Rating................	115

PROXIMATE ANALYSIS OF FUEL AS FIRED.

Fixed Carbon.........	40.6%
Volatile Matter......	28.2%
Ash..................	14.3%
Moisture.............	16.9%

B. T. U. per lb...... 8500

EVAPORATION TEST NO. B-12, Mar.23, 1921

Builders Rating of Boiler -- 2197 sq.ft. Heating Surface, 44 sq.ft. Grate Area; 220 H.P.
Method of Firing -- Hand Fired, Dutch Oven
Kind of Coal Used -- Cadomin Steam

Cost of Fuel Per Ton at Bunker	---
Percentage of Moisture	1.5
Total Coal Fired(Wet)	7200
Total Coal Fired(Dry)	7092
Average Coal Consumption Per Hour	900
Ash, Clinker and Refuse	1326
Total Combustible	5666

Average Pressure and Temperatures.

Steam Pressure Gauge	147.2
Temperature Feed Water, Degrees F	172.8
Draft over Fire......Inches of Water	.52
Barometer............Inches of Mercury	27.48
CO_2	7.6
Temperature of Flue Gas, Ave., Degrees F	419

Water

Total Water Evaporated at 172.8°F.Coal.as.Fired	55531
Water Evaporated Per Hour	6941
Total Equiv.Evap.From and at 212°F	59529
Hourly Equiv.Evap.From and at 212°F	7441

Economic Results

Water Evaporated Per lb.Coal(Actual Conditions)	7.72
Equiv.Evap.Per lb.Coal From and at 212°F	8.27
Equiv.Evap.Per lb.Coal(Dry)From and at 212°F	8.40
Equiv.Evap.Per lb.Coal(Combustible) " 212°F	10.51
Cost of Evaporation per 1,000 lbs. Water	---
Cost of Steam per H.P.Hour	---
Factor of Evaporation	1.072

Efficiency

Efficiency of Boiler and Furnace	63.6
H.P. Developed Per Hour	215
Percentage of Builders Rating	98

PROXIMATE ANALYSIS OF FUEL AS FIRED. ASH.

Fixed Carbon	57.4%	) Combustible	40.6%
Volatile Matter	26.2%	)	
Ash	14.9%		53.4%
Moisture	1.5%		6.0%

B. T. U. per lb........12570

NOTE: Black smoke for 3 minutes after firing.

(Sgd.) Charles A. Robb.

BIBLIOGRAPHY.

ALLAN, J. A.:
"The Mineral Resources of Alberta", First Annual Report, Mines Branch, Alta., p.46,1920.

BLIZARD, J.& MALLOCH, E.S.:
"Results of Forty-one Steaming Tests conducted at the Fuel Testing Station, Ottawa, Bull. No. 27, Mines Branch, Can., 1920

FIELDNER, A.C.:
"Notes on the Sampling and Analysis of Coal." Technical Paper No.76, U. S. Bureau of Mines, 1914.

HOLMES, J. A.:
"The Sampling of Coal in the Mine," Technical Paper No. 1, U. S. Bureau of Mines, 1918.

HAANEL, B. F.:
"The Investigation of Six Samples of Alberta Lignites." Report No.331, Mines Branch, Can., 1914.

PARR, S.W. & WHEELER, W.F.:
"The Weathering of Coal." Bull. 38, Eng. Exp.Stat., Univ. Ill., 1909.

POPE, G.S.:
"Methods of Sampling Delivered Coal." Bull. 116, U. S. Bureau of Mines, 1916.

POPE, G. S.:
"Directions for Sampling Coal for Shipment or Delivery," Technical Paper No. 133, U.S. Bureau of Mines, 1917.

PORTER, J. B.:
"Coals of Canada," Report 83, Mines Branch, Can., 1912.

PORTER, H.C., & OVITZ,F.K.:
"Deterioration and Spontaneous Heating of Coal in Storage," Technical Paper No.16, U.S. Bureau of Mines, 1912.

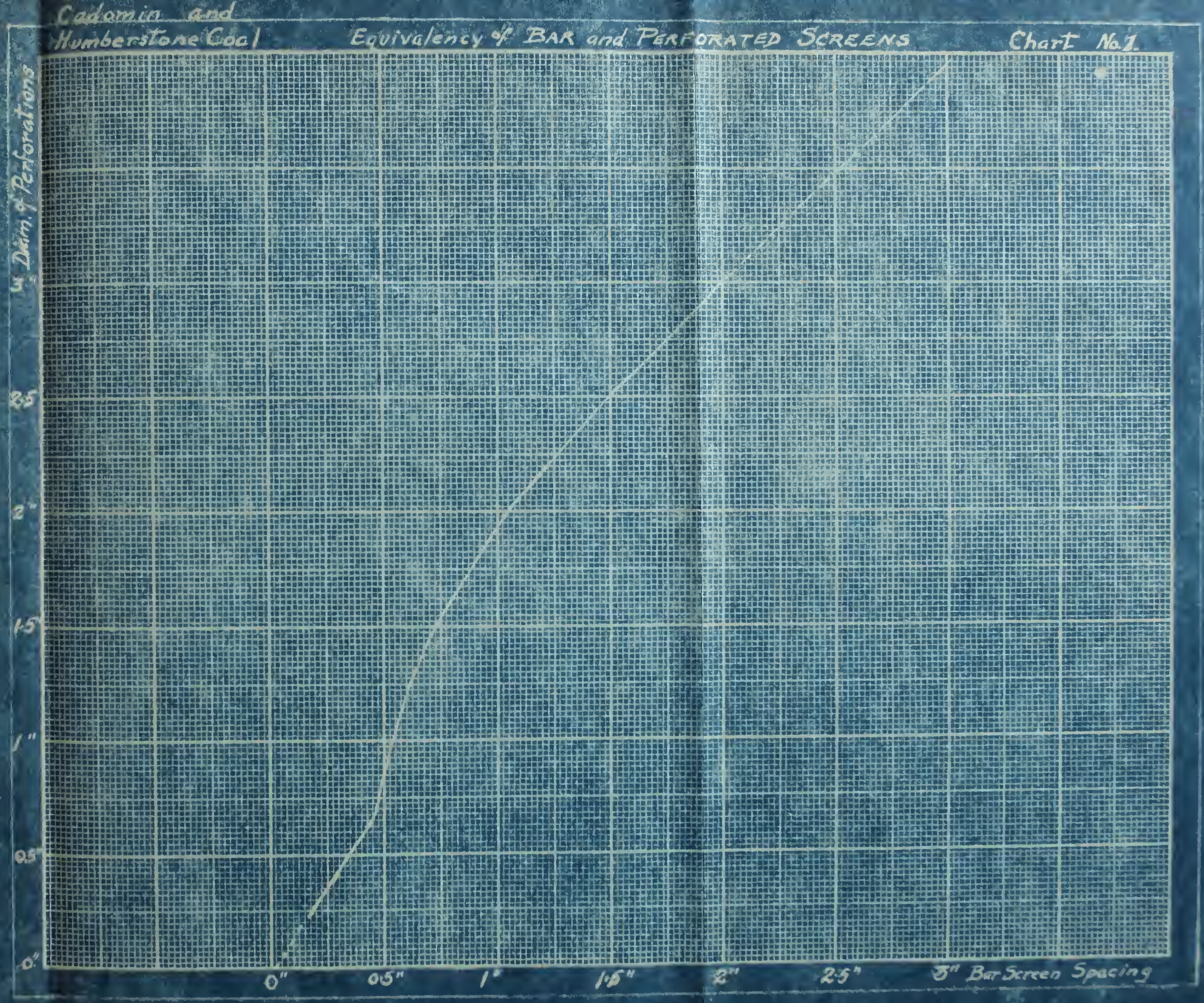
SCOTT, W. W.:
"Standard Methods of Chemical Analysis," 1917.

STANSFIELD, E., & NICOLLS, J. H.:
"Analysis of Canadian Fuels, Part IV,"
Bull. No. 25, Mines Branch, Can., 1918.

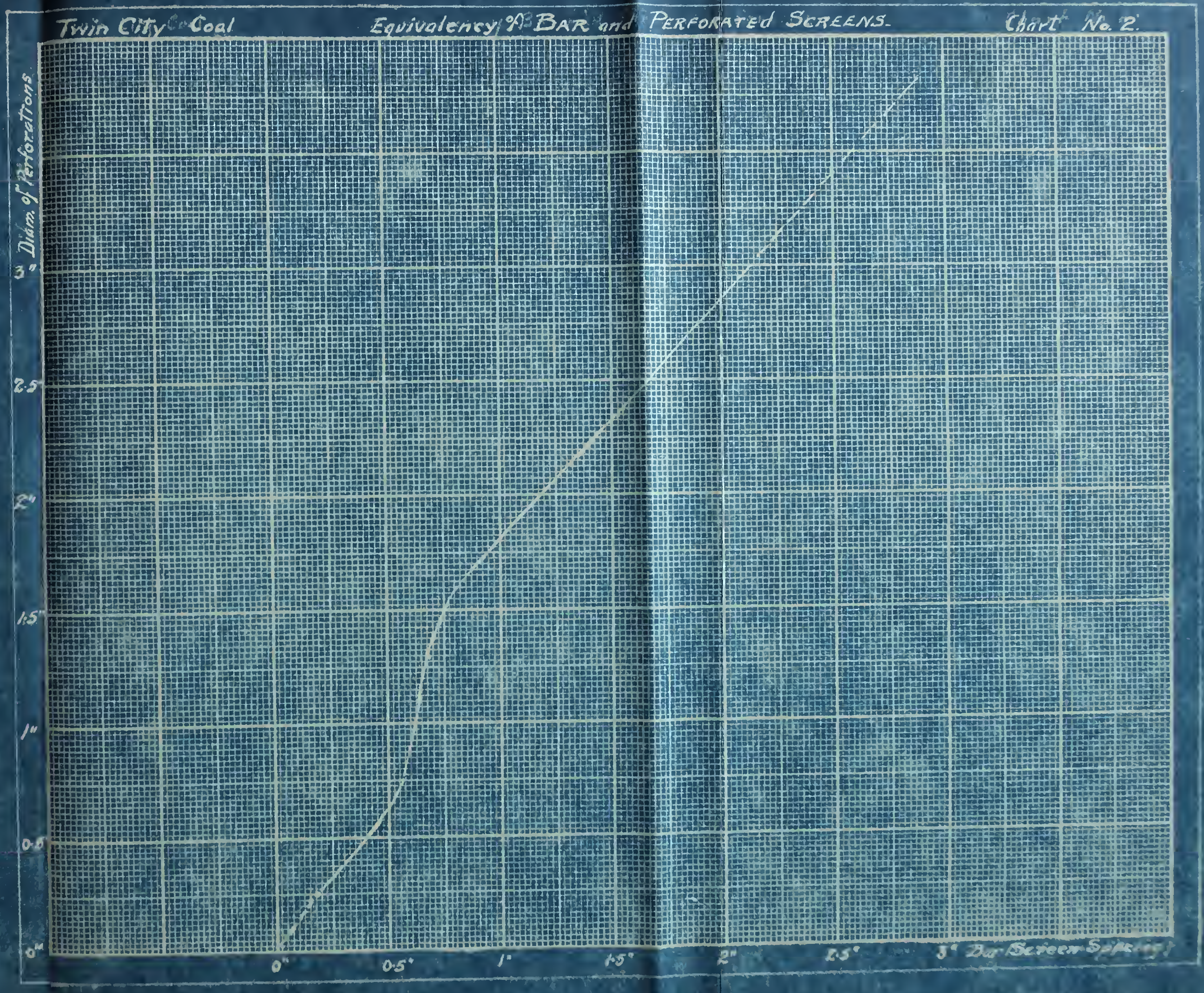
STOEK, H.H., HIPPARD, C. W. and LANGTRY, W.D.:
"Bituminous Coal Storage Practice," Bull.
No.116, Eng. Exp.Station, Univ.Illinois, 1920.

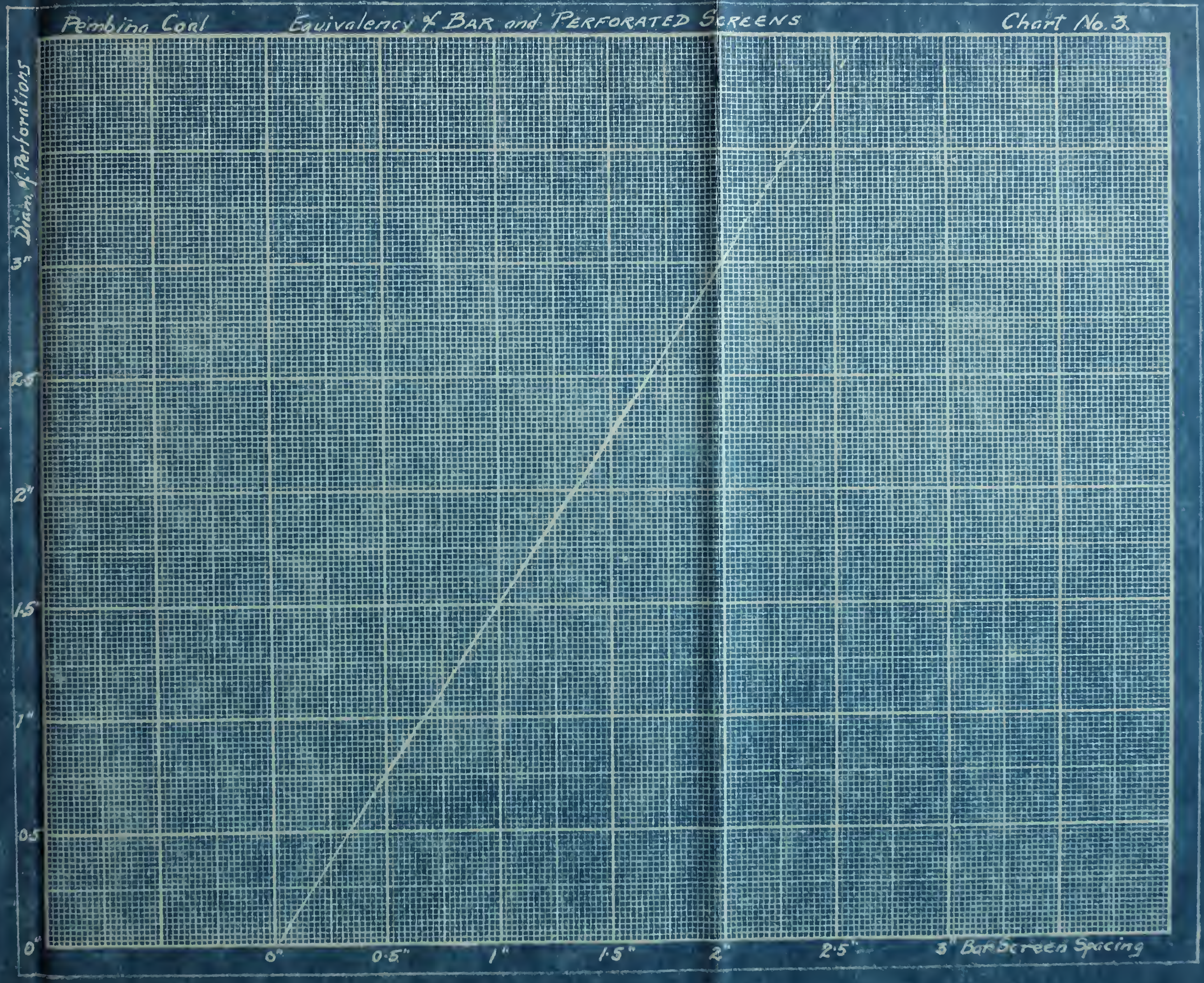
WESTERN CANADA COAL REVIEW:
Editorial, p.23, April 1921.

LIST OF CHARTS.



Cadomin and
Humberstone Coal
Equivalency of BAR and PERFORATED SCREENS
Chart No.1.
Diam. of Perforations
3"
2.5"
2"
1.5"
1"
0.5"
0"
0"
0.5"
1"
1.5"
2"
2.5"
3" Bar Screen Spacing

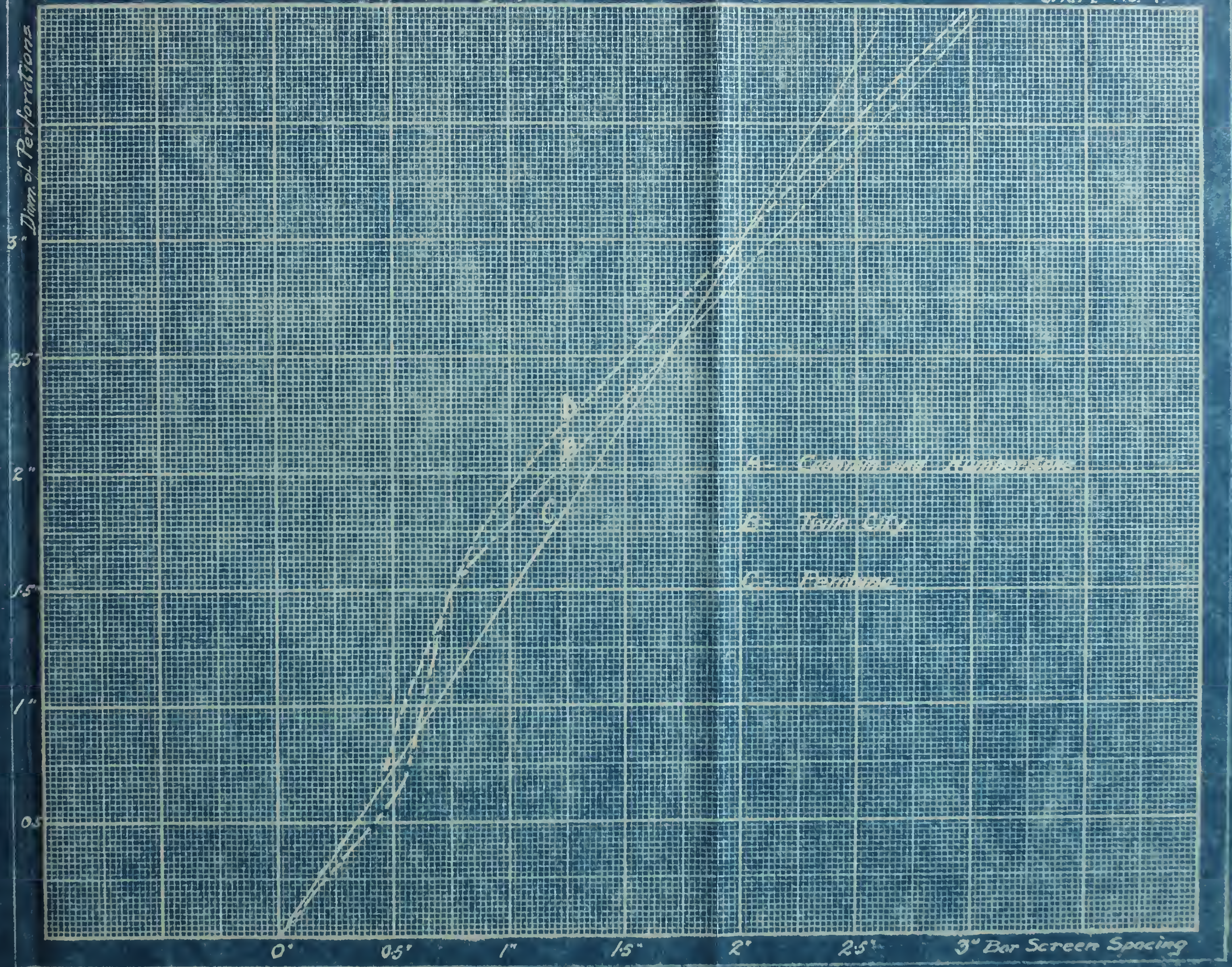

Twin City Coal
Equivalency of Bar and Perforated Screens.
Chart No. 2.
Diam. of Perforations.
3"
2.5"
2"
1.5"
1"
0.5"
0"
0"
0.5"
1"
1.5"
2"
2.5"
3" Bar Screen Spacing

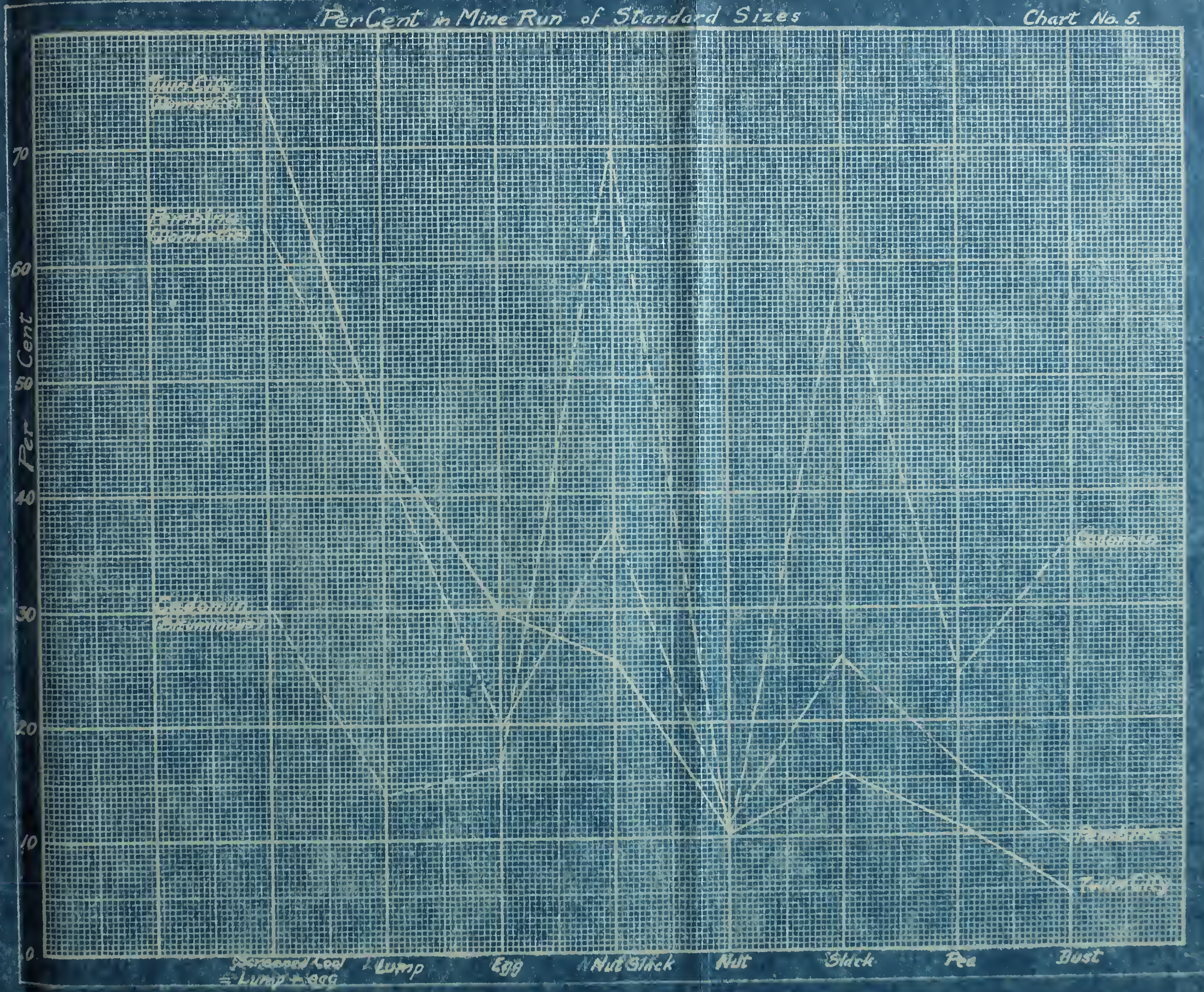


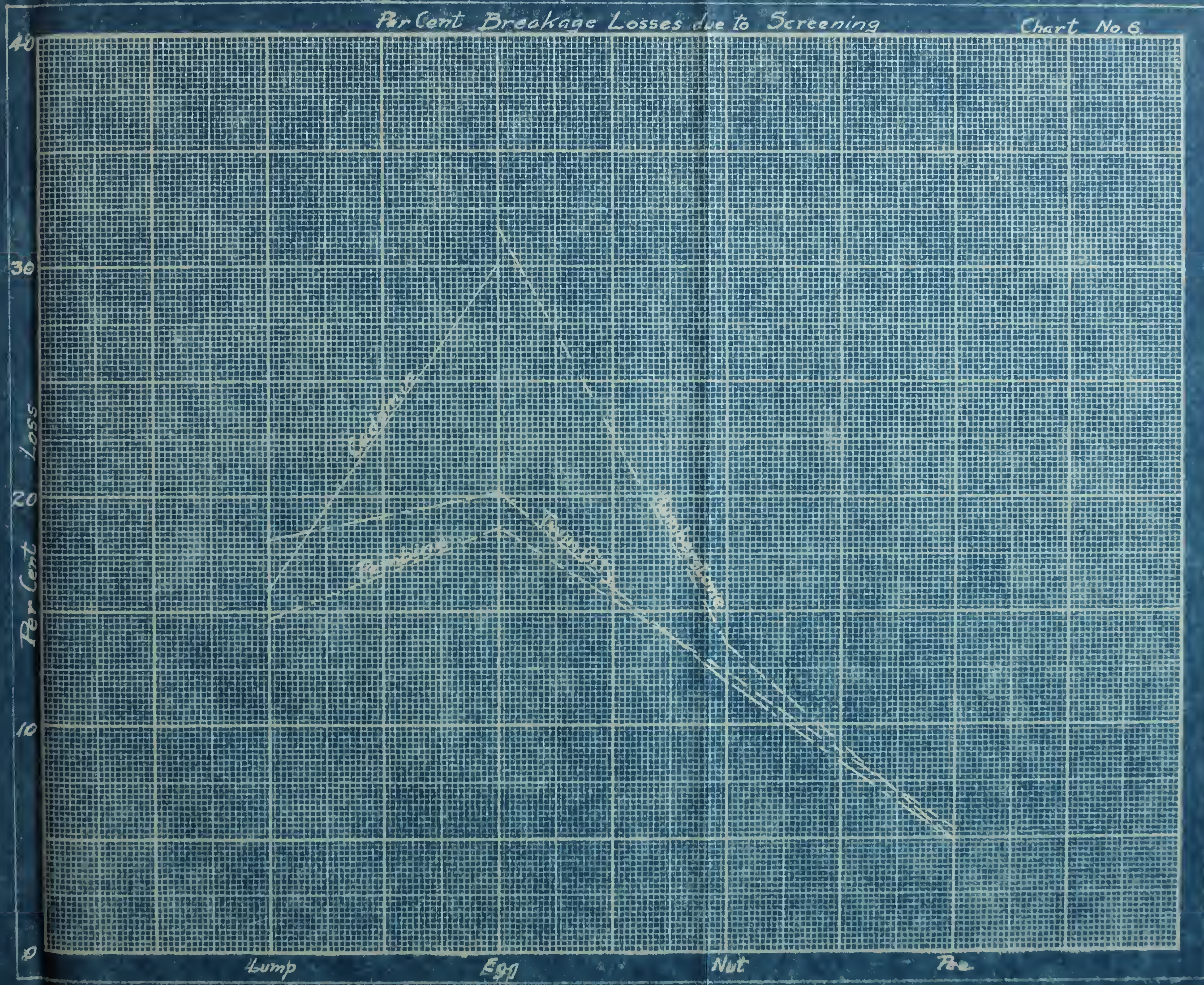
Pembina Coal
Equivalency of BAR and PERFORATED SCREENS
Chart No. 3.
3" Diam. of Perforations
2.5"
2"
1.5"
1"
0.5
0"
0"
0.5"
1"
1.5"
2"
2.5"
3" Bar Screen Spacing

Equivalency of Bar and Perforated Screens

Chart No. 4

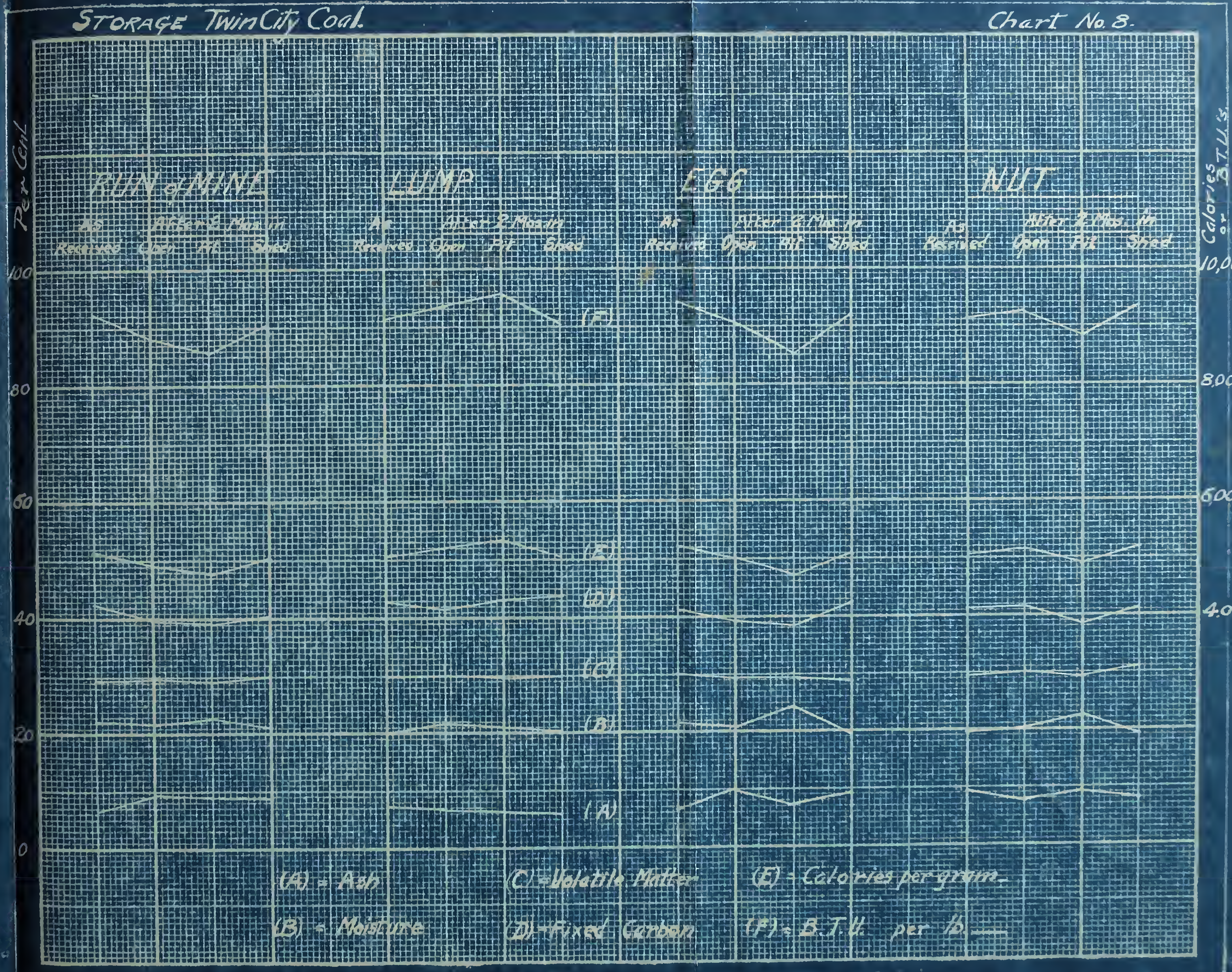



Per Cent in Mine Run of Standard Sizes
Chart No. 5.
Per Cent
70
60
50
40
30
20
10
0
Screened Coal = Lump + egg
Lump
Egg
Nut Slack
Nut
Slack
Pea
Dust
Twin City

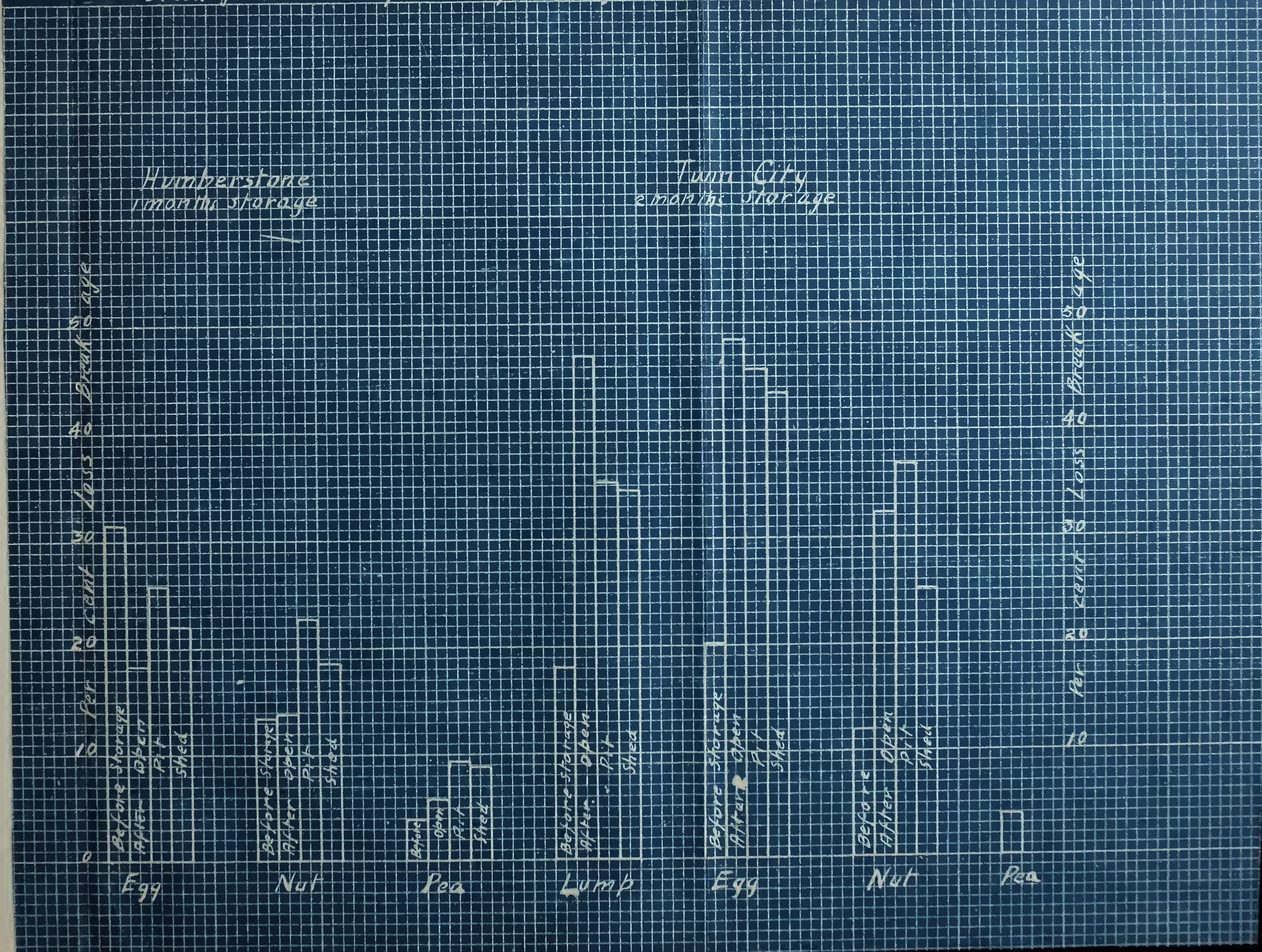


Per Cent Breakage Losses due to Screening
Chart No. 6
Per Cent Loss
40
30
20
10
0
Lump
Egg
Nut
Pea

Storage Humberstone Coal. Chart No. 7

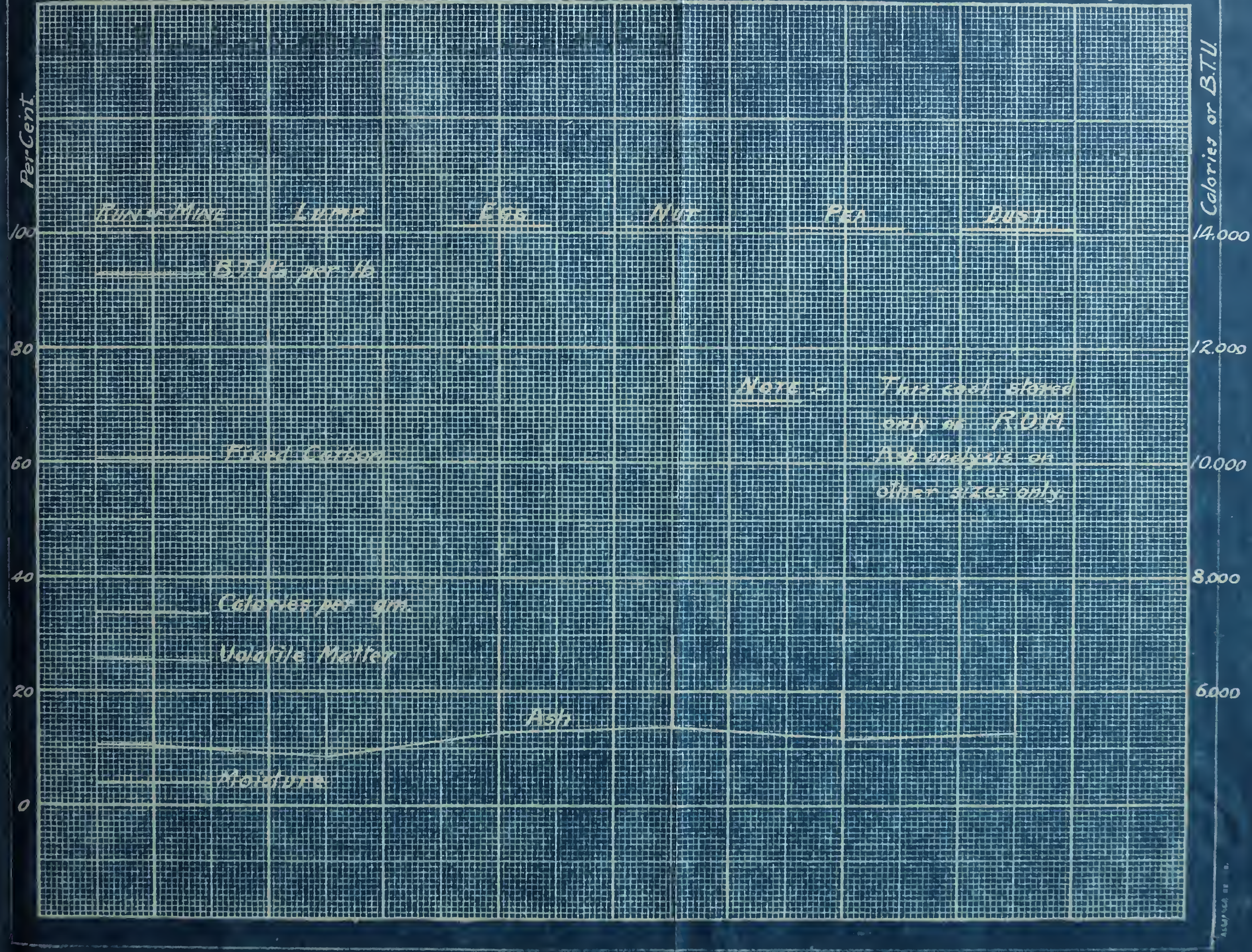

STORAGE Twin City Coal.
Chart No. 8.
Per Cent
Calories or B.T.U.'s.
RUN of MINE
LUMP
EGG
NUT
As Received
After 2 Mos. in Open Pit Shed
100
80
60
40
20
0
10,000
8,000
6,000
4,000
(F)
(E)
(D)
(C)
(B)
(A)
(A) = Ash
(B) = Moisture
(C) = Volatile Matter
(D) = Fixed Carbon
(E) = Calories per gram.
(F) = B.T.U. per lb.

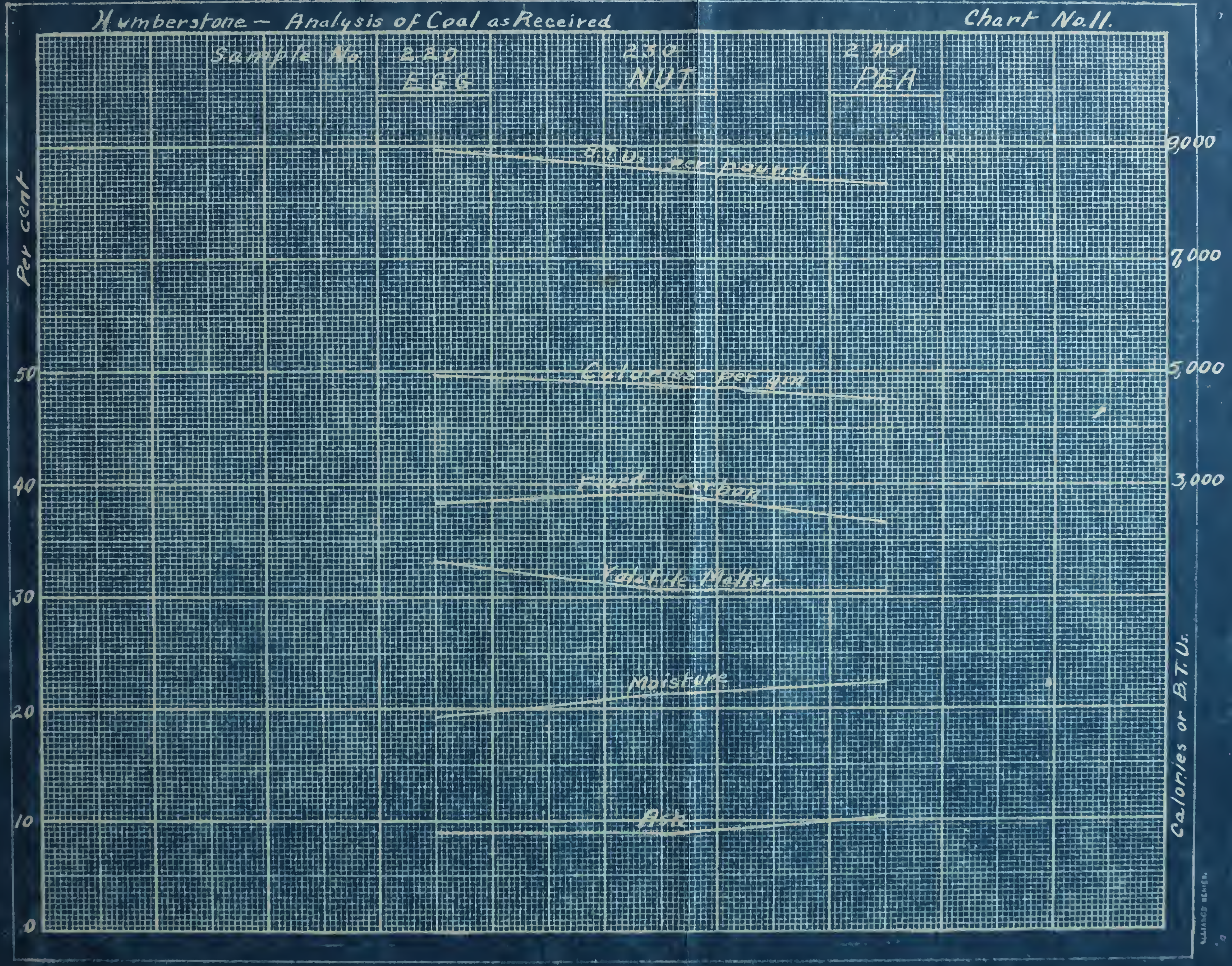
Breakage Losses Before and After Storage (Due to screening) Chart No. 9.



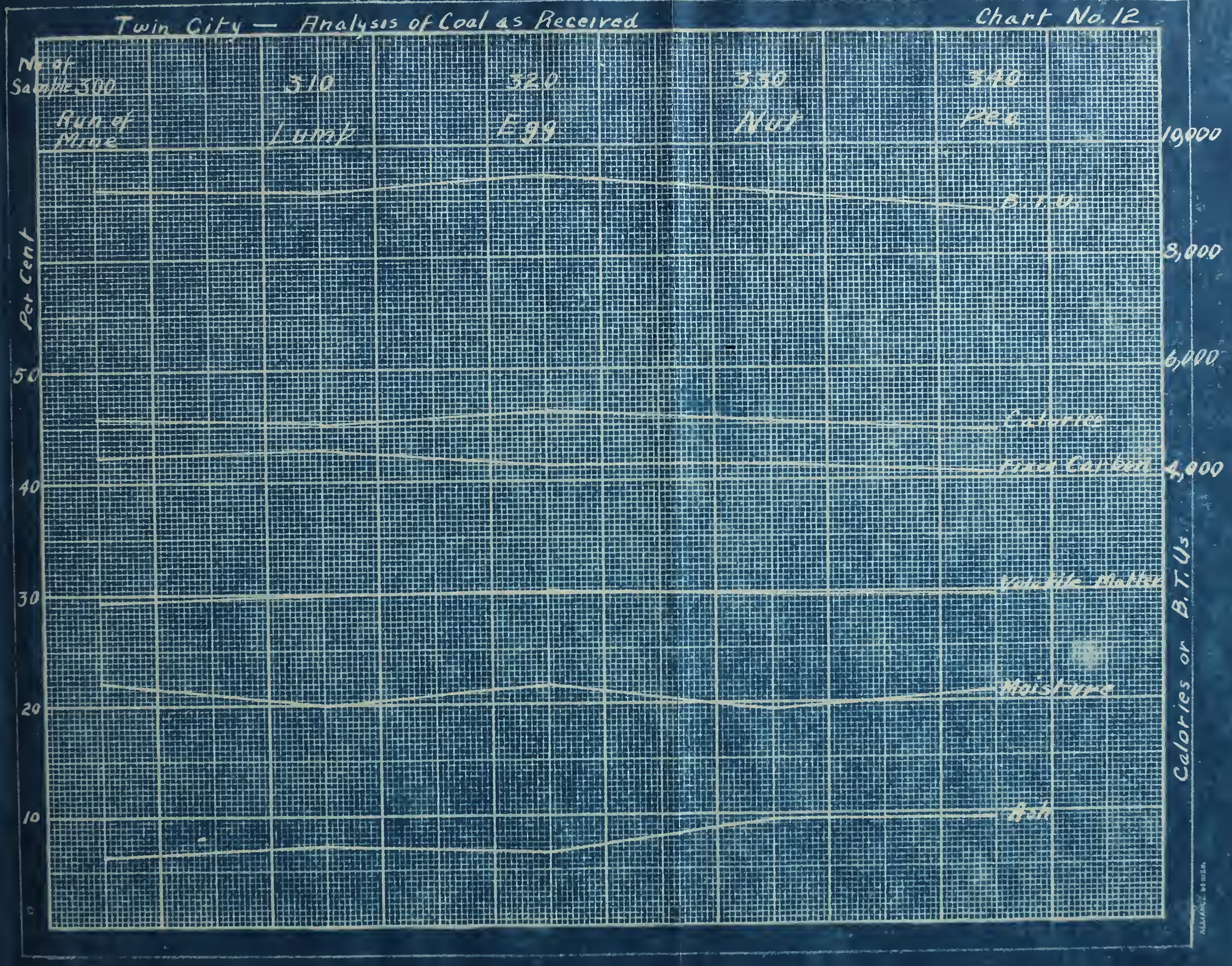
Cadomin- Analysis of Coal as Received-

Chart No. 10.

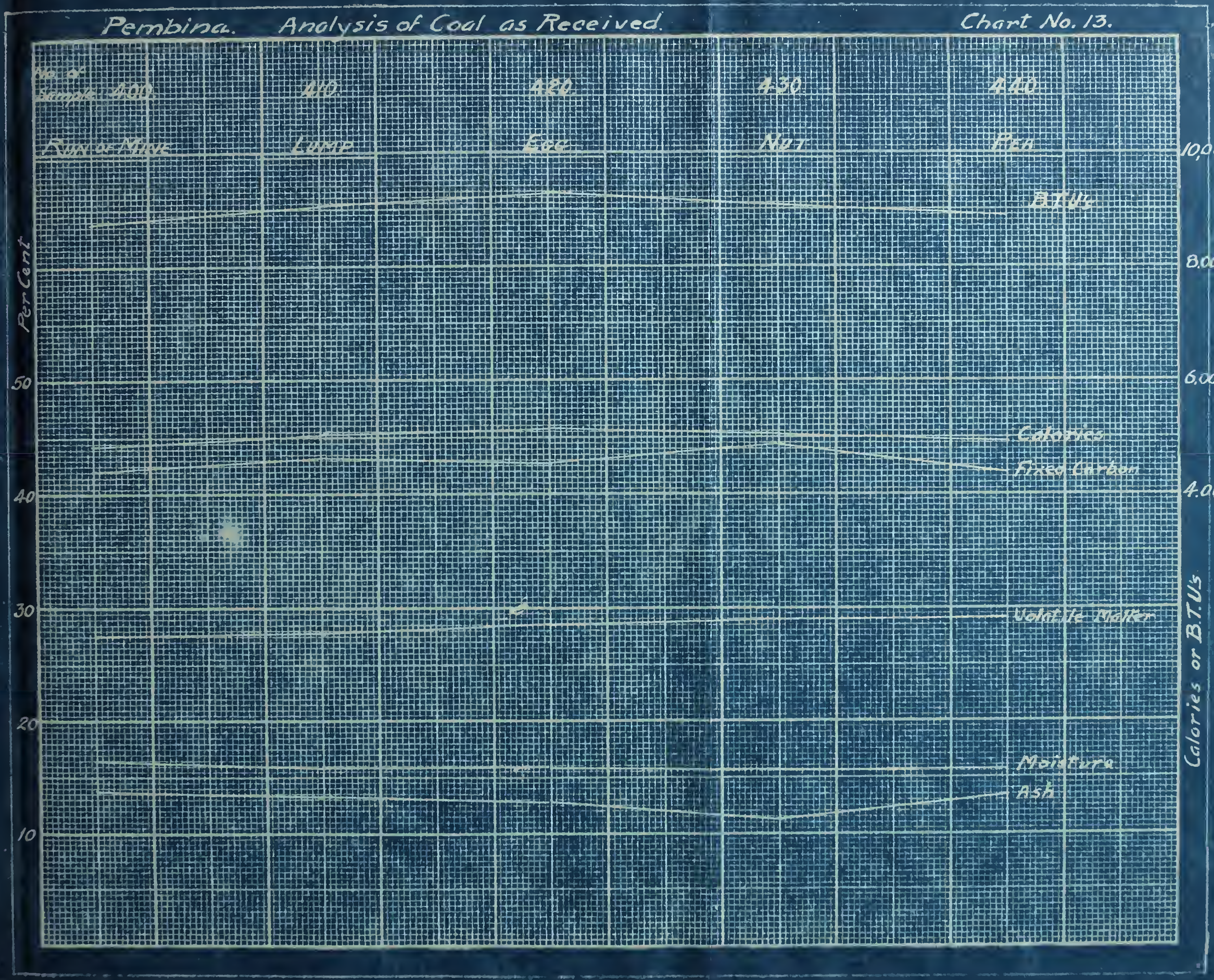




Humberstone - Analysis of Coal as Received
Chart No. 11.
Sample No.
220
EGG
230
NUT
240
PEA
B.T.Us. per pound
Calories per gm
Fixed Carbon
Volatile Matter
Moisture
Ash
Per cent
50
40
30
20
10
0
9,000
7,000
5,000
3,000
Calories or B.T.Us.

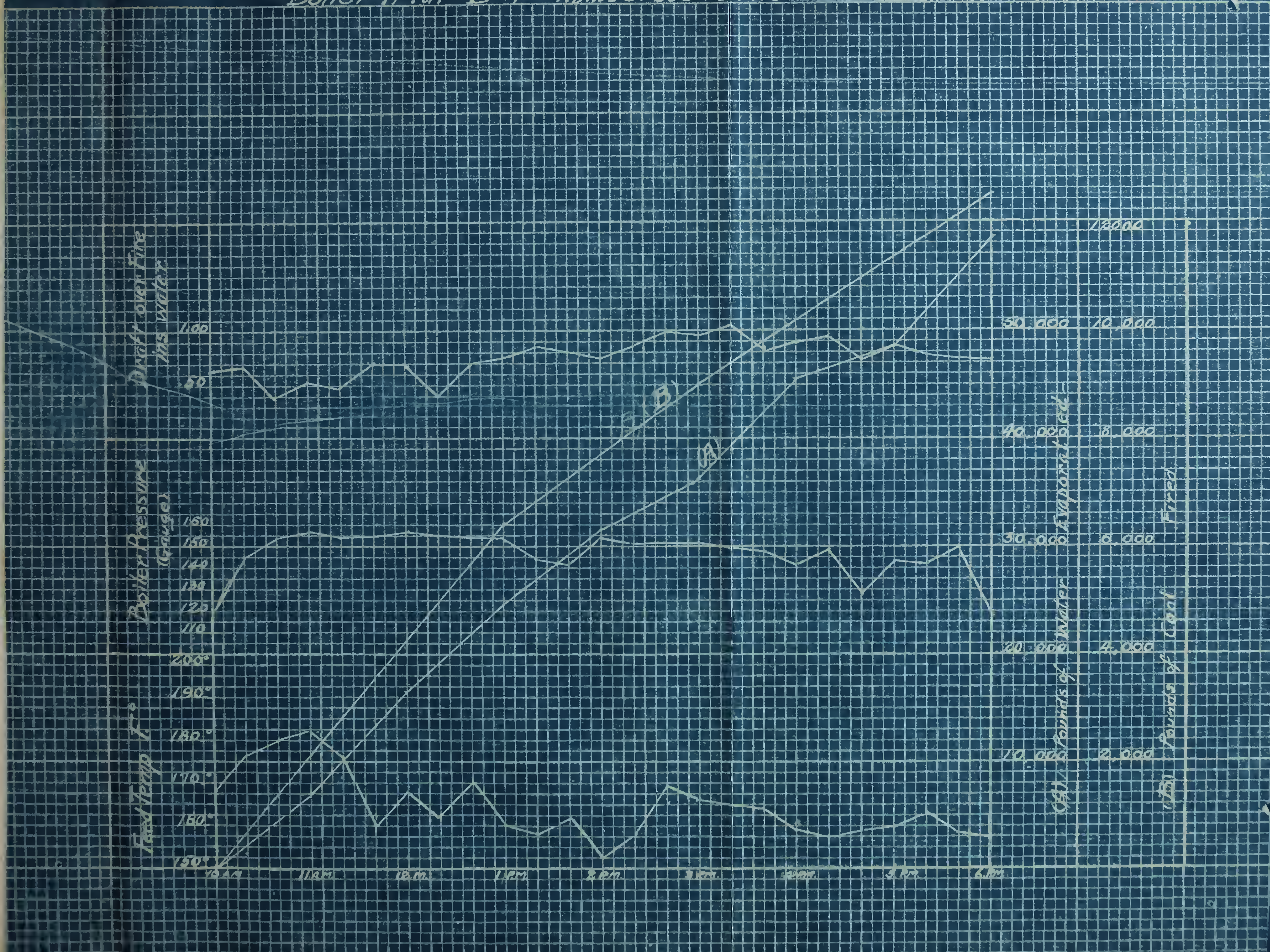


Twin City — Analysis of Coal as Received
Chart No. 12
No. of Sample 300
310
320
330
340
Run of Mine
Lump
Egg
Nut
Pea
B.T.Us.
Calories
Fixed Carbon
Volatile Matter
Moisture
Ash
Per Cent
50
40
30
20
10
0
10,000
8,000
6,000
4,000
Calories or B.T.Us.

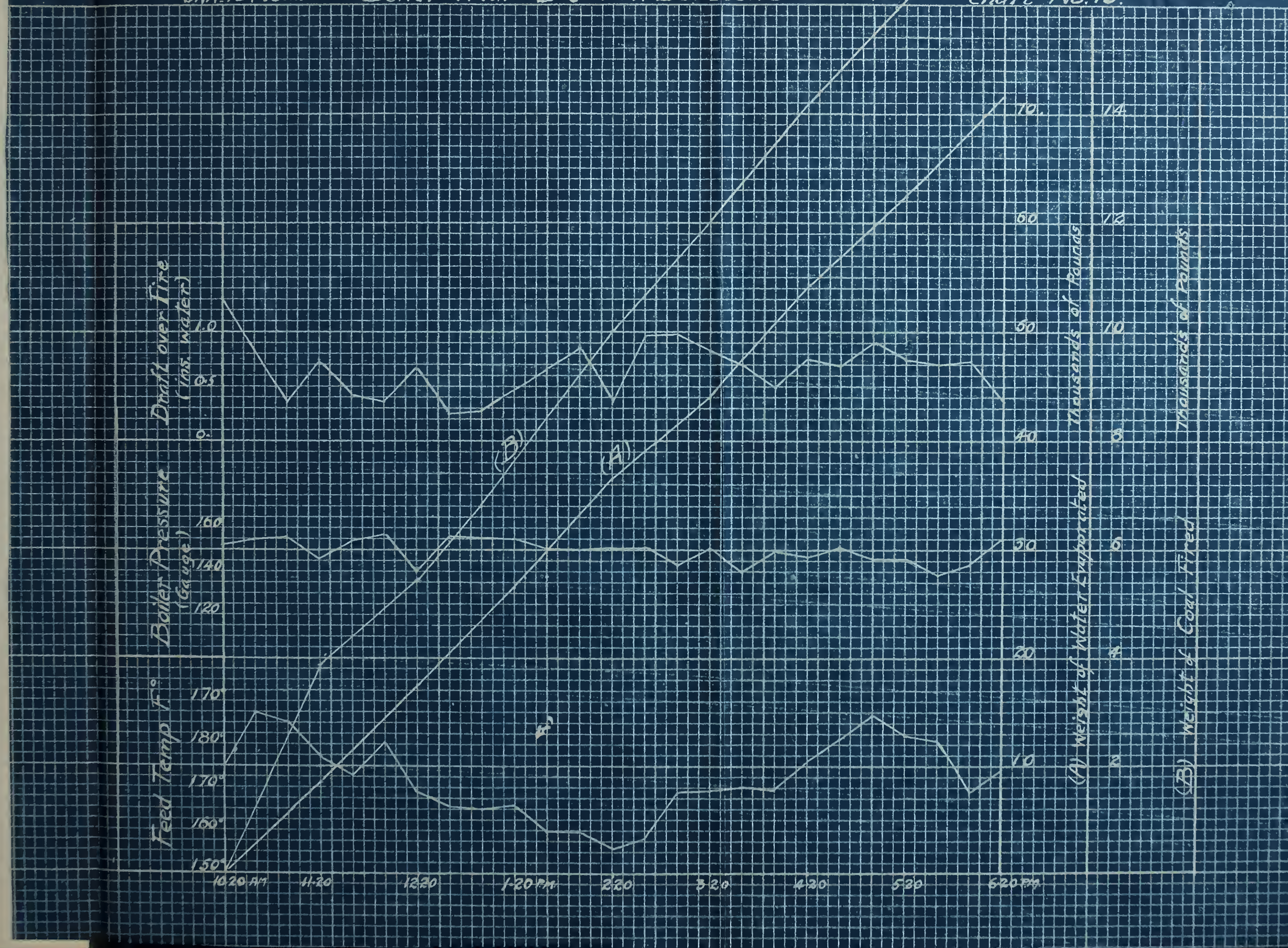


Pembina. Analysis of Coal as Received.
Chart No. 13.
No. of Sample 400
410
420
430
440
Run of Mine
Lump
Egg
Nut
Pea
B.T.U.s
Calories
Fixed Carbon
Volatile Matter
Moisture
Ash
Per Cent
50
40
30
20
10
10,000
8,000
6,000
4,000
Calories or B.T.U.s

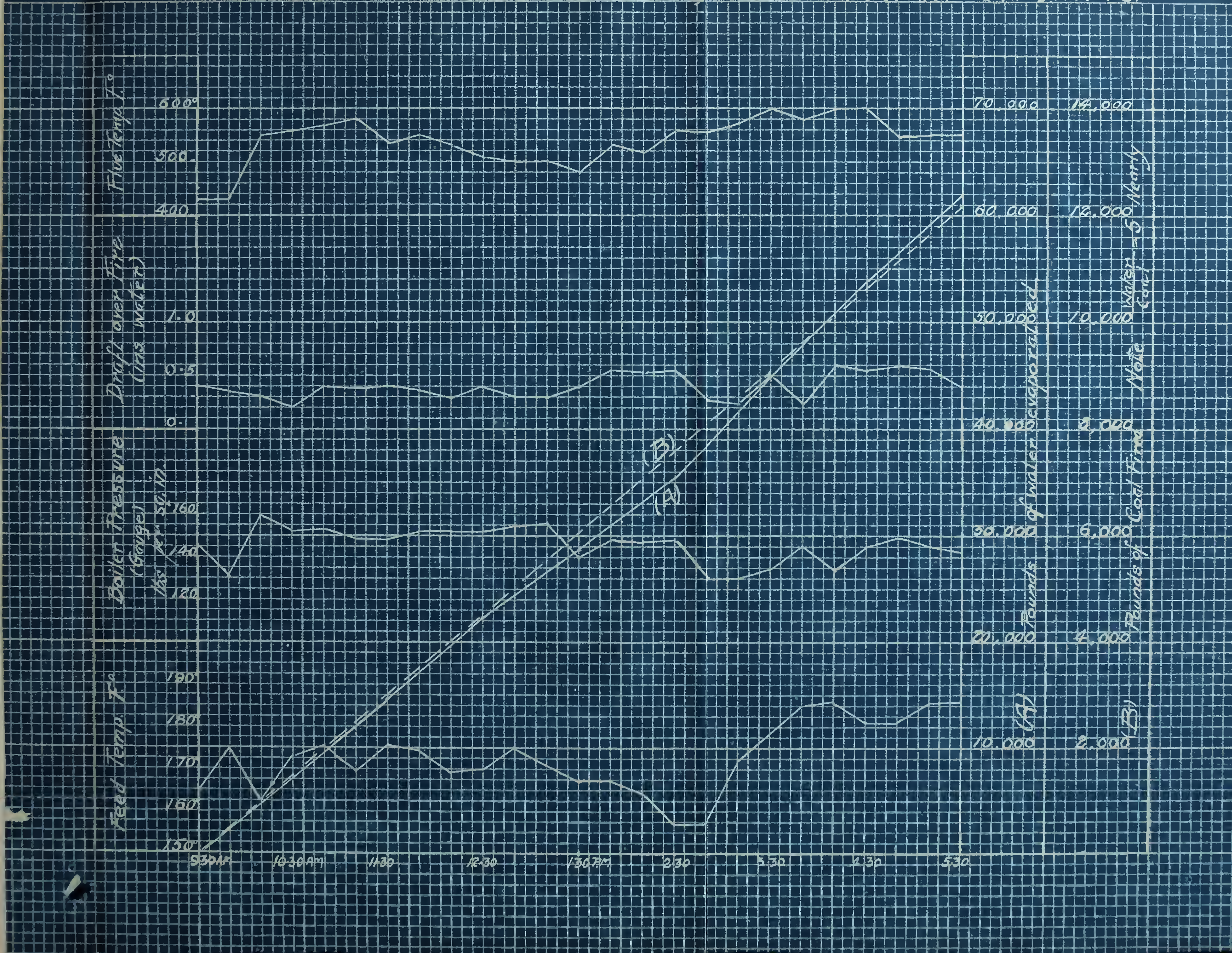
Boiler Trial B-4 Humberstone Nut JAN. 11, 1921. Chart No. 14

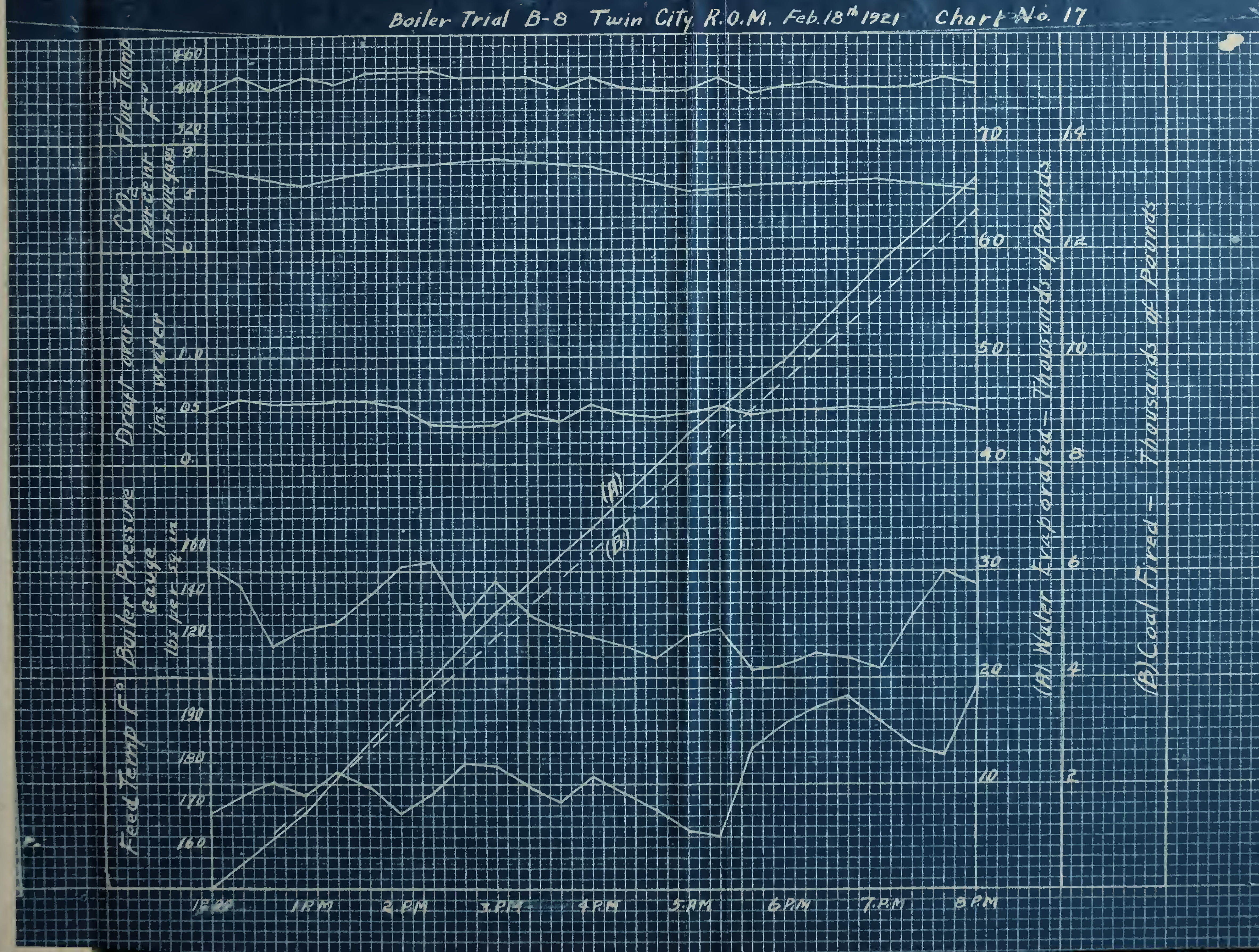


JAN. 13. 1921. Boiler Trial B-5 Humberstone Slack Chart No. 15.



Boiler Trial B-7 Twin City R.O.M. FEB. 17. 1921 Chart No. 16.

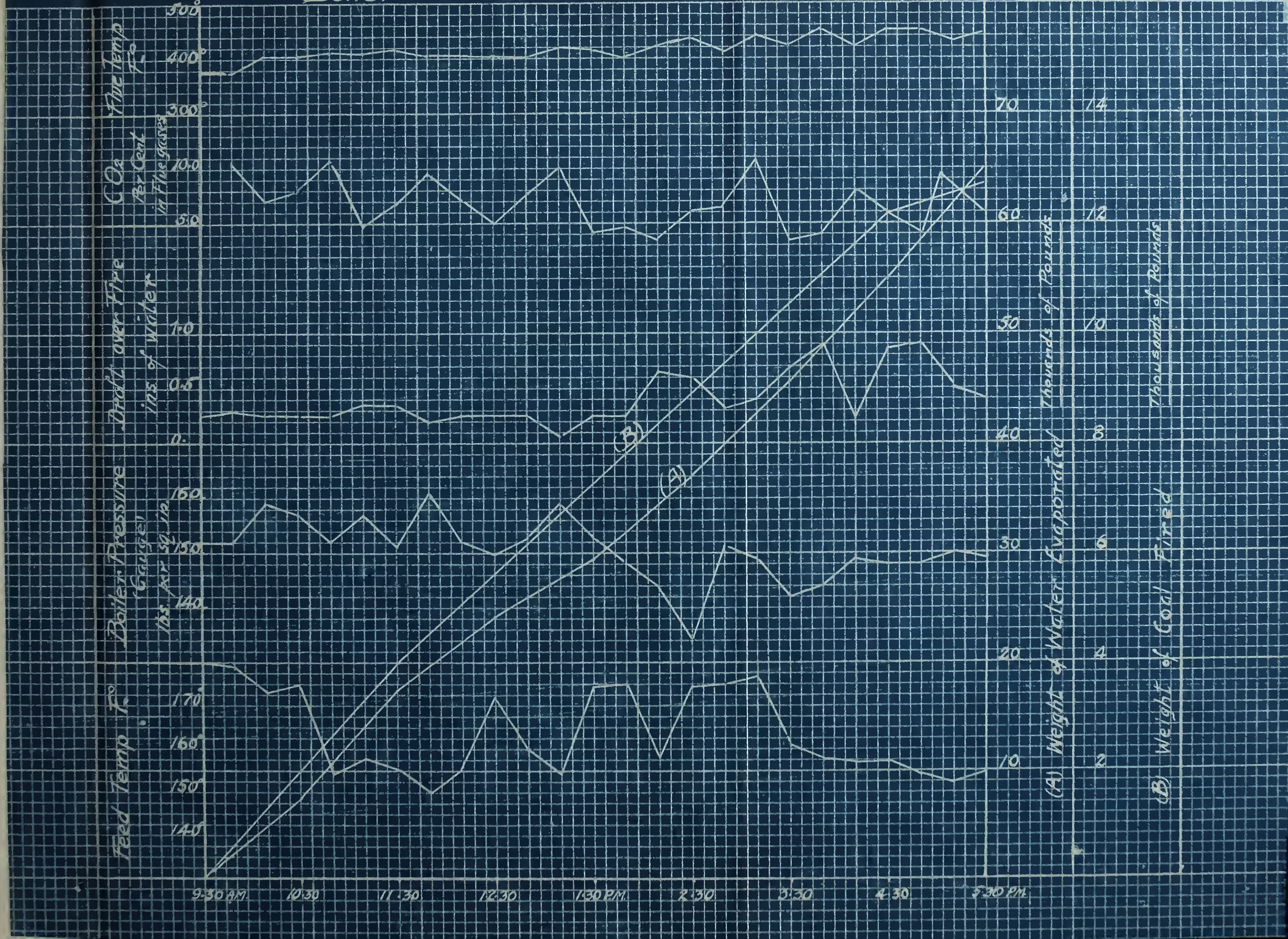


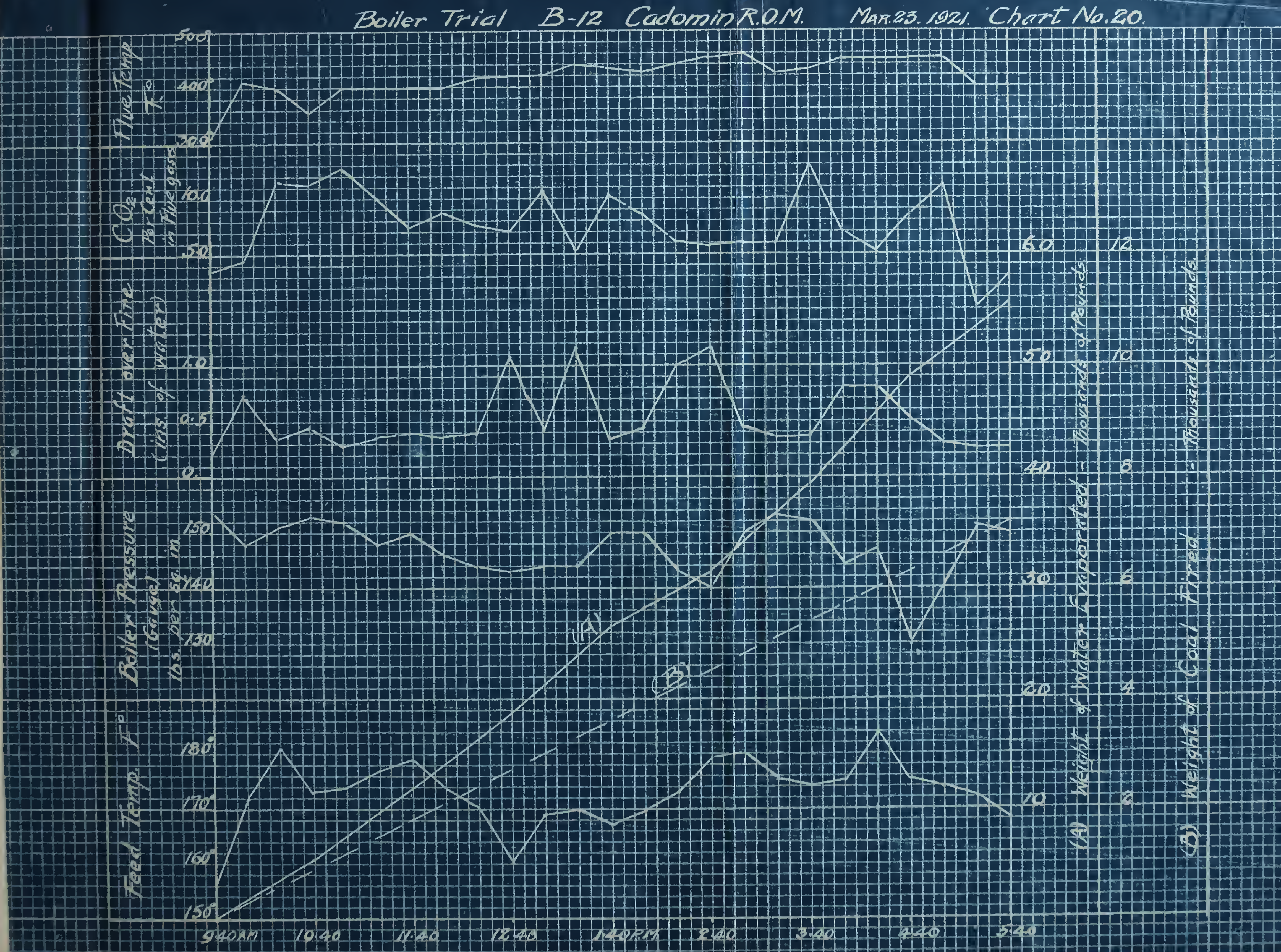


Boiler Trial B-8 Twin City R.O.M. Feb. 18th 1921 Chart No. 17
Flue Temp F°
CO_2 per cent in flue gases
Draft over Fire ins. Water
Boiler Pressure Gauge lbs per sq in
Feed Temp F°
(A) Water Evaporated - Thousands of Pounds
(B) Coal Fired - Thousands of Pounds
(A)
(B)
12 PM
1 PM
2 PM
3 PM
4 PM
5 PM
6 PM
7 PM
8 PM

Boiler Test B-9 Pembina R.O.M. MAR. 3, 1921. Chart No. 18.
Flue Temp. F°
550
450
350
CO2 per Cent in Flue Gases
10.0
5.0
Draft over Fire ins. of water
1.0
0.5
0.
Boiler Pressure (Gauge) lbs. per sq. in.
170
150
130
110
Feed Temp. F°
170
160
150
140
10 AM
11
12
1 P.M.
2
3
4
5
6
(A)
(B)
70
60
50
40
30
20
10
14
12
10
8
6
4
2
(A) Weight of Water Evaporated - Thousands of Pounds
(B) Weight of Coal Fired Thousands of Pounds

Boiler Trial. B-10. Pembina R.O.M. Mar. 4, 1921. Chart No. 19.

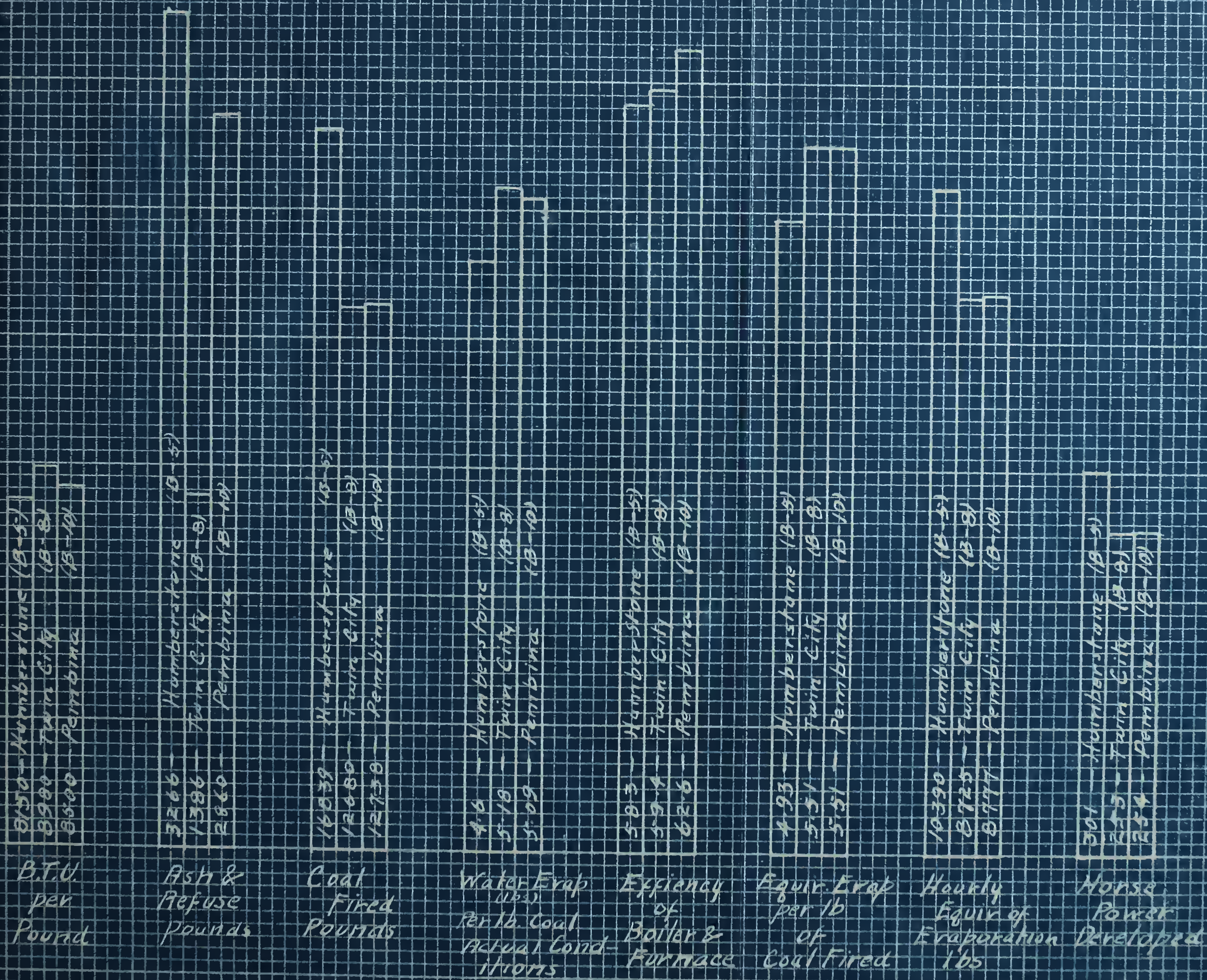


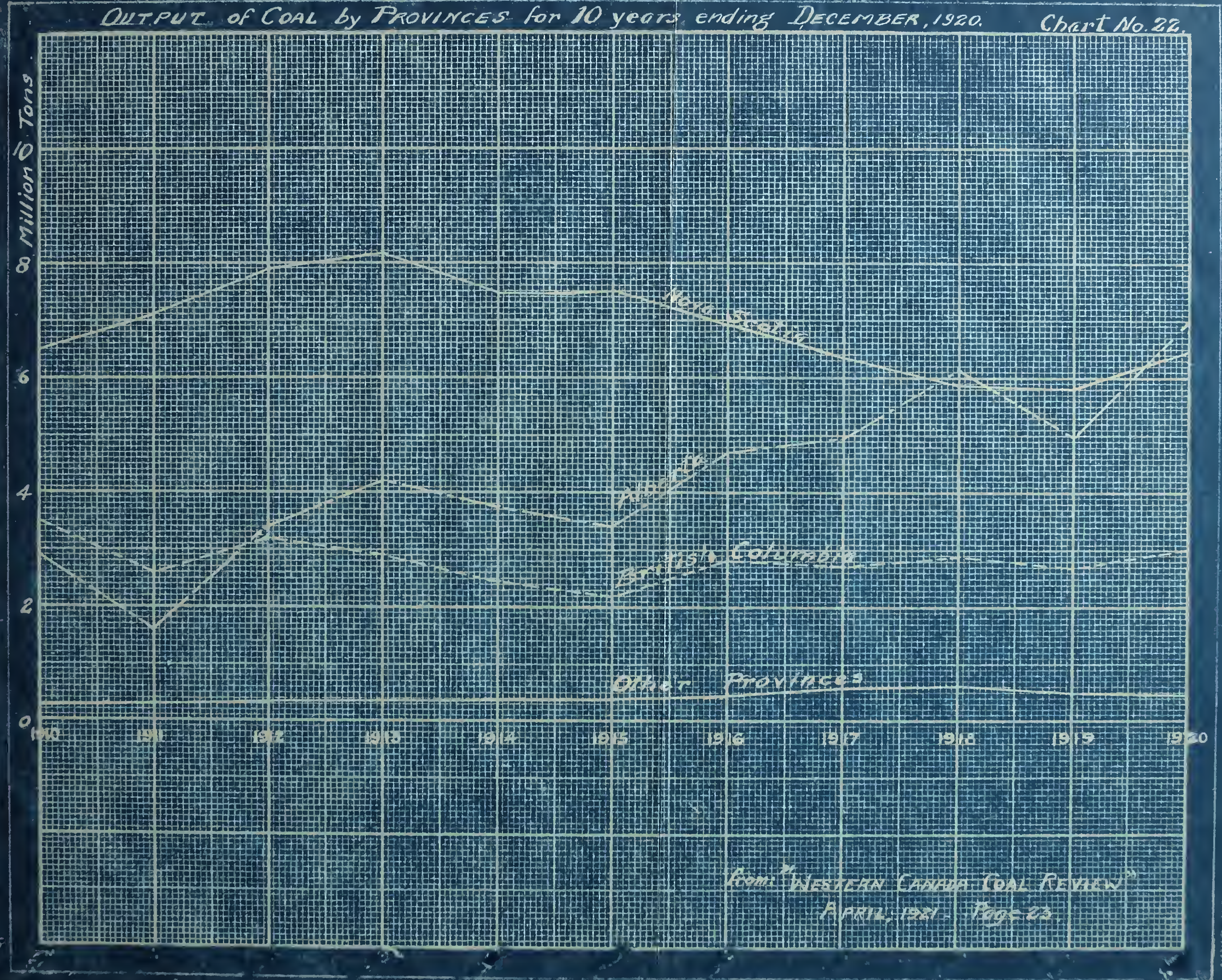


Boiler Trial B-12 Cadomin R.O.M. Mar. 23. 1921. Chart No. 20.
Flue Temp. F°
CO2 Per Cent in Flue gas
Draft over Fire (ins. of water)
Boiler Pressure (Gauge) lbs. per sq. in.
Feed Temp. F°
(A) Weight of Water Evaporated - Thousands of Pounds
(B) Weight of Coal Fired - Thousands of Pounds
(A)
(B)
9.40 AM
10.40
11.40
12.40
1.40 P.M.
2.40
3.40
4.40
5.40

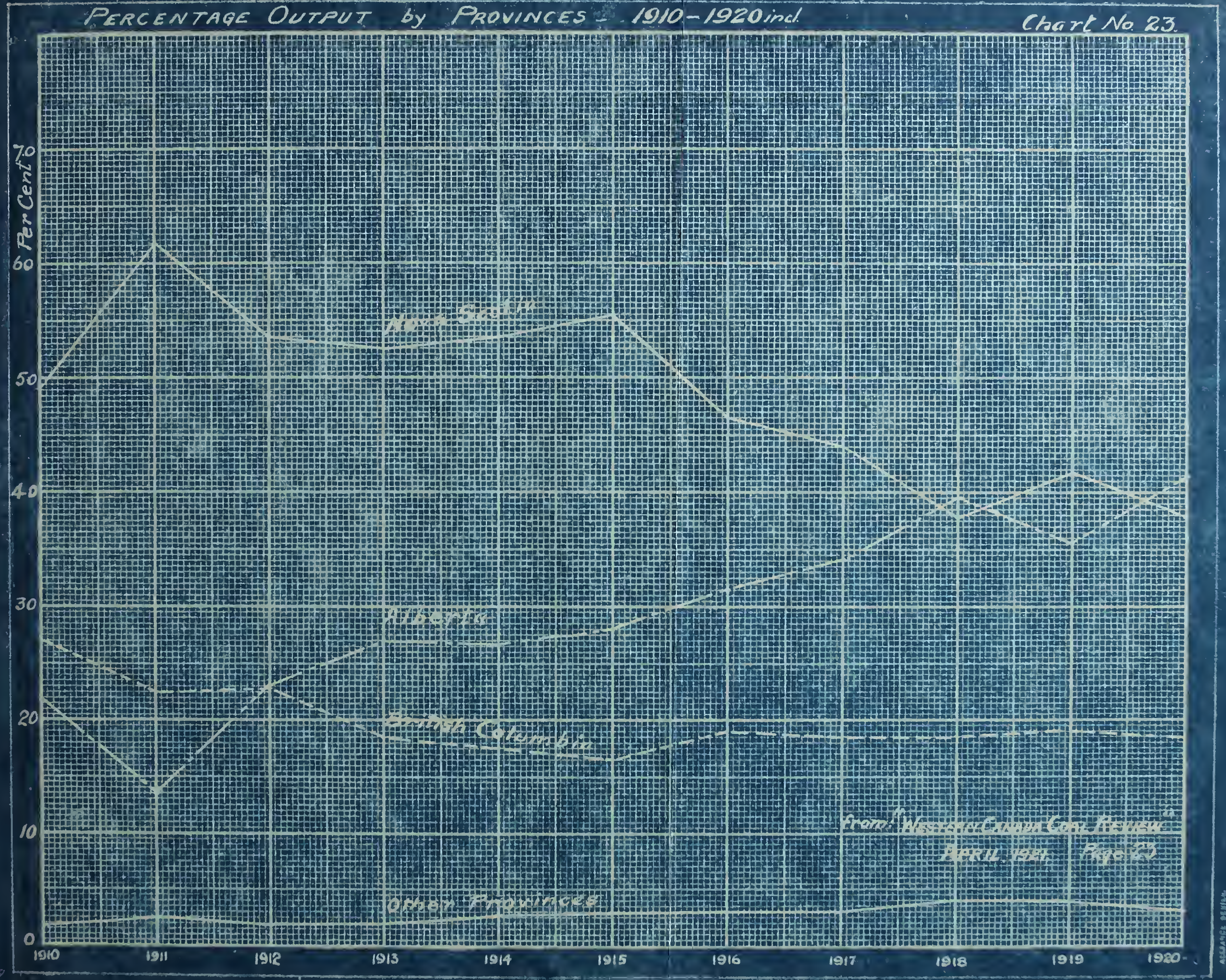
Comparison of 7 Important Results of Boiler Trials (Hand Fired) Chart No. 21.

Comparison of 7 Important Results of Boiler Trials (Stoker Fired) Chart No 21a





OUTPUT of COAL by PROVINCES for 10 years ending DECEMBER, 1920.
Chart No. 22.
Million Tons
10
8
6
4
2
0
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
Nova Scotia
Alberta
British Columbia
Other Provinces
From: "WESTERN CANADA COAL REVIEW"
APRIL, 1921 Page 23.



PERCENTAGE OUTPUT by PROVINCES - 1910-1920 incl.
Chart No. 23.
Per Cent
70
60
50
40
30
20
10
0
Nova Scotia
Alberta
British Columbia
Other Provinces
From "Western Canada Coal Review"
April 1921. Page 27
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920